This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

No. 109a

U. S. HYDROGRAPHIC OFFICE

CONTRIBUTIONS TO TERRESTRIAL MAGNETISM

THE VARIATION OF THE COMPASS

1895

Astr. 6278.95.3

Harvard College Library

FROM THE

UNITED STATES GOVERNMENT

THROUGH

U. S. Hydrographic office.

10 May, 1895.

SCIENCE CENTER LIBRARY

U. S. — Bureau of navig. — Hydrog. office.

[Publ.] No. 109a.

Bureau of navigation.

U. S. HYDROGRAPHIC OFFICE.

CONTRIBUTIONS TO TERRESTRIAL MAGNETISM,

THE VARIATION OF THE COMPASS.

AS OBSERVED AT FIFTY OF THE PRINCIPAL MARITIME STATIONS
FROM THE EARLIEST TIMES TO THE PRESENT, TOGETHER
WITH EQUATIONS FOR EACH STATION, FROM WHICH
VALUES MAY BE PREDICTED AND ANNUAL
RATES OF CHANGE FOUND.

Compiled by Geo: Washington Littlehales.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1895.

~~[illegible] .96.5~~

Astr. 6278.95.3

HARVARD COLLEGE
[illegible] 10 1895
LIBRARY.

[illegible] Segretario, Uffizi

PREFACE.

In this publication G. W. Littlehales, C. E., of the United States Hydrographic Office, has presented his discussion of part of the observations of the magnetic declination or variation of the compass that have been collected by him, in the Division of Chart Construction, during the last ten years. The present results relate to Aden (Arabia), Arica (Peru), Ascensiòn Island (South Atlantic Ocean), Auckland (New Zealand), Bahia (Brazil), Batavia (Java), Bombay (India), Barbados (West Indies), Buenos Ayres (Argentine Republic), Callao (Peru), Cartagena (Colombia), Cape of Good Hope (Africa), Charlottetown (Prince Edward Island), Concepcion (Chile), Coquimbo (Chile), Curaçao (West Indies), Fayal (Azores Islands), the Galapagos Islands, Halifax (Nova Scotia), Habana (Cuba), Hongkong (China), La Guayra (Venezuela), Lagoon Head (Mexico), Magdalena Bay (Mexico), Manila (Philippine Islands), Martinique (West Indies), City of Mexico, Montevideo (Uruguay), Nagasaki (Japan), Nossy Vé (Madagascar), Panama (Colombia), Payta (Peru), Peking (China), Pernambuco (Brazil), Petropaulowski (Siberia), Puna and Guayaquil (Ecuador), Punta Arenas (Chile), Rio de Janeiro (Brazil), St. Johns (Newfoundland), San Blas (Mexico), St. Helena (South Atlantic Ocean), St. Vincent (Cape Verde Islands), San Diego (California), Shanghai (China), Singapore (Malay Peninsula), Surabaya (Java), Sydney (Australia), Tahiti (Society Islands), Valparaiso (Chile), and Vera Cruz (Mexico).

There are also recorded in a form for discussion 1,953 observations at 920 other important maritime stations, and it is proposed to investigate these as soon as the collections of data have become sufficient.

Mr. Littlehales desires to acknowledge the assistance that has been received in the prosecution of this work from Mr. J. S. Siebert in 1888 and 1889, from Mr. C. S. Craig in 1890 and 1891, from Mr. E. G. Russell in 1892 and 1893, and from Mr. M. E. Porter in 1894 and 1895.

C. D. SIGSBEE,
Hydrographer.

UNITED STATES HYDROGRAPHIC OFFICE,
Washington, D. C., March 15, 1895.

INTRODUCTION.

The observations that are discussed in this publication have been collected, during the period elapsed since 1885, with a view of providing for the deduction of values of the rates of secular change of the variation of the compass for use on the nautical charts of the regions in which the stations are situated. The results as presented also give values of the variation throughout the range of observation, and for the years 1895, 1900, and 1905, and provide the means for readily deducing the value of the variation for any past year not greatly beyond the range of observation, and also for predicting, within an assigned measure of precision, values for the years up to 1910, for the purpose of stating the correct direction of the magnetic meridian on the charts.

To each series of observations there has been adapted a periodic function of the form $v = A + B_1 \sin \frac{360^\circ}{m} t + B_2 \cos \frac{360^\circ}{m} t$, in which v represents the variation, m the period of the cycle, t the time in years and fractions of a year reckoned from the epoch 1850, and A, B_1 and B_2 constants that are determined from the observations by the method of least squares. In this manner the rate of movement of the compass needle is found for any epoch within the range of observation, the times when the needle is stationary are computed, and the values of the declination are predicted for current use for ten or fifteen years beyond the limits of the period of observation.

THE VARIATION OF THE COMPASS.

Lat. 12° 47′ N. **ADEN.** Long. 44° 59′ E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
1612	° 13.16	13.66, Middleton, 1612 12.66, Dounton, 1612	Hansteen's Magnetismus der Erde, Christiania, 1819.
1674	15.00		Do.
1723	13.77	13.83, Matthews, 1723 13.70, Matthews, 1723	Do.
1811	8.50		Becquerel's Traité du Magnetisme.
1825	8.70	Owen	Do.
1834	5.03	Haines	Phil. Trans. Royal Society, Part I, 1875.
1849	4.38	4.28, Keller, 1849 4.48, Keller, 1849	Annales Hydrographiques, 1851.
1857	4.25	Moyes	Phil. Trans. Royal Society, Part I, 1875.
1887	3.93	Lieut. W. P. Ray, U. S. N	Hydrographic Office Publication, No. 109, Contributions to Terrestrial Magnetism.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
1612	° 13.17	° 12.93	+0.24	0.0576	Probable error of a single observed value = ±43′. Period = 440 years.
1674	15.00	15.40	−0.40	0.1600	
1723	13.77	14.30	−0.53	0.2809	
1811	8.50	7.97	+0.53	0.2809	
1825	8.70	6.88	+1.82	3.3124	
1834	5.03	6.17	−1.14	1.2996	
1849	4.38	5.31	−0.93	0.8549	
1857	4.25	4.71	−0.46	0.2116	
1887	3.93	3.53	+0.40	0.1600	
				6.6179	

Empirical equation for determining the variation for any year: $v = 9.20 - 4.24 \sin \frac{9}{11}(t - 1850) - 4.09 \cos \frac{9}{11}(t - 1850)$.

Lat. 18° 28′ S. **ARICA, PERU.** Long. 70° 20⅛′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1713......	— 8.00	....	Brewster's Treatise on Mag., Edinb., 1834.
1821......	—10.42	B. Hall	Becquerel's Traité du Magnetisme.
1827......	—10.75	....	Sabine's Collection, Phil. Trans. Royal Society, 1877.
1835......	—11.00	....	
1858......	—10.88	....	
1883......	—10.00	Ensign Favereau, Fr. N....	Annales Hydrographiques, 2d series, 1884.
1893......	— 9.87	Lieut. Mottez, Fr. N..........	Annales Hydrographiques, 2d vol., 1893.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1713......	— 8.00	— 8.026	+0.03	0.0009	Probable error of single observation = ± 06′. Period = 240 years.
1821......	—10.42	—10.581	+0.16	0.0256	
1827......	—10.75	—10.692	—0.06	0.0036	
1835......	—11.00	—10.793	—0.21	0.0441	
1858......	—10.88	—10.738	—0.14	0.0196	
1883......	—10.00	—10.072	+0.07	0.0049	
1893......	— 9.87	— 9.808	—0.06	0.0036	
				0.1023	

Empirical equation for finding the variation for any year: $v = -9.4 + 0.223 \sin 1.5\,(t - 1850) - 14.61 \cos 1.5\,(t - 1850)$.

Lat. 7° 55.5′ S. **ASCENSION ISLAND.** **Long. 14° 24′ W.**

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1700	—2.00		Halley, in his Tabula Nautica, etc.
1754.3	8.10	De la Caille	Hansteen's Magnetismus der Erde, Christiana, 1819.
1768.25	9.88	Wallis	Do.
1775.4	10.87	Cook	Do.
1806.3	15.67	Bousoe	Do.
1816	15.50	Brine	Becquerel's Traité du Magnetisme.
1825	16.87	Duperrey	Do.
1830 *	20.16	Foster	Phil. Trans. Royal Society, Part II, 1877.
1836	17.60	Fitz Roy	Do.
1839	18.52	Du Petit Thouars	Do.
1842	19.27	Belcher	Do.
1846	19.27	Bérard	Do.
1861	21.75	Denham	Do.
1863	21.63	H. M. S. Hecate	Do.
1876.25	22.77 {23.10 22.53 22.68}	Nares and Thomson, R.N.	Report of Voyage of H. M. S. Challenger.
1890.3	23.00 {22.6 23.4}	E. D. Preston, assistant, United States Coast and Geodetic Survey.	Bulletin No. 23, United States Coast and Geodetic Survey, March, 1891.

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.	
	°	°			
1700	—2.00	—2.47	+0.47	0.2209	Probable error of a single observation = ± 22.6′. Period = 600 years.
1754.3	8.10	7.68	+0.42	0.1764	
1768.25	9.88	9.66	+0.22	0.0484	
1775.4	10.87	10.66	+0.21	0.0441	
1806.3	15.67	14.93	+0.74	0.5476	
1816	15.50	16.15	+0.65	0.4225	
1825	16.87	17.23	—0.36	0.1296	
1836	17.60	18.62	—1.02	1.0404	
1839	18.52	18.95	—0.43	0.1849	
1842	19.27	19.27	0.00	0.0000	
1846	19.27	19.70	—0.43	0.1849	
1861	21.75	21.13	+0.62	0.3844	
1863	21.63	21.31	+0.32	0.1024	
1876.25	22.77	22.32	+0.45	0.2025	
1890.3	23.00	23.15	—0.15	0.0225	
				3.7115	

* Omitted in investigation.

Empirical equation for determining the variation for any year: $v = 10.55 + 9.47 \sin 0.6 (t - 1850) + 9.56 \cos 0.6 (t - 1850)$.

Lat. 36° 50′ S. **AUCKLAND, NEW ZEALAND.** Long. 174° 49′ E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1848......	—14. 18	Stokes......................	Phil. Trans. Royal Society, Part II, 1877.
1855......	—14. 25	H. M. S. Pandora............	Letter from British hydrographer to United States hydrographer, dated Feb. 8, 1890; received at Hydrographic Office Feb. 27, 1890.
1859......	—13. 90	Novara Expedition..........	
1884.4....	—13. 75	H. M. S. Dart.................	
1891......	—14. 08	Lieut. Courmes, Fr. N......	Annales Hydrographiques, 2d series, 2d vol., 1892.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1848......	—14. 18	—14. 15	0. 03	0. 0009	Probable error of a single observation = ±9.96′. Period = 327.3 years.
1855......	—14. 25	—14. 00	0. 16	0. 0256	
1859......	—13. 90	—14. 06	—0. 16	0. 0256	
1884.4....	—13. 75	—13. 94	—0. 19	0. 0361	
1891......	—14. 08	—13. 92	0. 16	0. 0256	
				0. 1138	

Empirical equation for finding the variation for any year: $v = -13.077 + 0.2295 \sin 1.1\,(t-1850) - 1.052 \cos 1.1\,(t-1850)$.

Lat. 13° S. **BAHIA, BRAZIL.** Long. 38° 32 W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1708......	—11. 50	Noel........................	Hansteen's Magnetismus der Erde, Christiana, 1819.
1819......	1. 97	Roussin....................	Becquerel's Traité du Magnetisme.
1822......	2. 00	Duperrey....................	Voyage autour du Monde, Paris, 1830.
1832......	4. 30	....	Phil. Trans. Royal Society, 1877.
1866......	7. 95	Harkness....................	Smithsonian Contributions to Knowledge, 1873, No. 239.
1873.9....	9. 15	Capts. Nares and Thomson, R. N.	Report of Scientific Results of Voyage of H. M. S. Challenger.
1881.3....	9. 33	Dr. Van Ryckworsel and E. Engelenburg, C. E.	Magnetic Survey of Eastern part of Brazil, published by Royal Academy of Sciences, Amsterdam, 1890.
1887.8....	10. 30	Lieutenant de Roujon, Fr. N.	Annales Hydrographiques, vol. 3, 1888.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1708......	—11. 50	—11. 56	+0. 06	0. 0036	Probable error of a single observation = ±15.36′. Period = 380 years.
1819......	1. 97	1. 80	+0. 17	0. 0189	
1822......	2. 00	2. 33	—0. 33	0. 1089	
1832......	4. 30	3. 99	+0. 31	0. 0961	
1866......	7. 95	8. 42	—0. 47	0. 2209	
1873.9....	9. 15	9. 08	+0. 07	0. 0049	
1881.3....	9 33	9. 52	—0. 19	0. 0361	
1887.8....	10. 30	9. 82	+0. 48	0. 2304	
				0. 7198	

Empirical equation for determining the variation for any year: $v = -0.78 + 7.86 \sin \frac{18}{19}(t-1850) + 7.40 \cos \frac{18}{19}(t-1850)$.

Lat. 6° 08′ S. **BATAVIA, JAVA.** Long. 106° 48′ E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1605......	+3.33	....	
1609......	+3.00	Saris........................	Hansteen's Magnetismus der Erde, Christiana, 1819.
1767......	+1.42	Wallis......................	Do.
1814......	—0.28	B. Hall.....................	Becquerel's Traité du Magnetisme.
1828......	—0.52	Blosseville..................	Phil. Trans. Royal Society, Part II, 1877.
1846......	—0.88	Elliot........................	Do.
1858......	—1.08	Novara Expedition.........	Do.
1876.5....	—1.70	Van Ryckworsel............	Published by Royal Academy of Sciences, Amsterdam.
1882.75...	—1.93	Van Stock..................	Magnetical and meteorological observations at the Batavian Observatory, Vols. VI and VII.
1883.5....	—1.93		
1884......	—1.91		
1885......	—1.89		

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1605......	+3.33	+2.94	+0.39	0.1521	Probable error of a single observation = ±15′. Period = 400 years.
1609......	+3.00	+3.12	—0.12	0.0144	
1767......	+1.42	+1.87	—0.45	0.2025	
1814......	—0.28	—0.34	+0.06	0.0036	
1828......	—0.52	—0.86	+0.34	0.1156	
1846......	—0.88	—1.35	+0.47	0.2209	
1858......	—1.08	—1.56	+0.48	0.2304	
1876.5....	—1.70	—1.67	—0.03	0.0009	
1882.75...	—1.93	—1.64	—0.29	0.0841	
1883.5....	—1.93	—1.64	—0.29	0.0841	
1884......	—1.91	—1.63	—0.28	0.0784	
1885......	—1.89	—1.63	—0.26	0.0676	
				1.2546	

Empirical equation for finding the variation for any year: $v=1.494-1.194 \sin 0.9\,(t-1850)-2.928 \cos 0.9\,(t-1850)$.

Lat. 18° 05.6′ N. **BOMBAY.** Long. 72° 54′ E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1722	+5.00	Mathews	Encyclopaedia Metropolitana, London, 1848.
1817	—0.00	Yates	Do.
1845	+0.22	Orlebar	Phil. Trans. Royal Society, Part I, 1875.
1847	—0.23	Montrion	Do.
1849	—0.25	F. A. E. Keller, Fr. Hydr. Engr.	Annales Hydrographiques, 1851.
1856	—0.32	Schlagintweit	Phil. Trans. Royal Society, Part I, 1875.
1867	—0.70	Chambers	Do.
1872	—0.85	—0.83, Chambers, 1871 —0.86, Chambers, 1872 —0.88, Chambers, 1873	Bombay magnetic and meteorological observations, 1871–78.
1875	—0.90	—0.89, Chambers, 1874 —0.90, Chambers, 1875 —0.91, Chambers, 1876	Do.
1878	—0.93	—0.925, Chambers, 1877 —0.933, Chambers, 1878	Do.
1881	—0.93	Chambers	Do.
1888.5	—0.82	—0.83, John Dover, 1888 —0.80, John Dover, 1889	Do.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1722	+5.00	+4.92	+0.08	0.0064	Probable error of a single observation = ± 12′. Period = 450 years.
1817	+0.00	+0.63	—0.63	0.3969	
1845	+0.22	—0.29	+0.51	0.2601	
1847	—0.23	—0.34	+0.11	0.0121	
1849	—0.25	—0.39	+0.14	0.0196	
1856	—0.36	—0.54	+0.18	0.0324	
1867	—0.70	—0.71	+0.01	0.0001	
1872	—0.85	—0.76	—0.09	0.0081	
1875	—0.90	—0.78	—0.12	0.0144	
1878	—0.93	—0.80	—0.13	0.0169	
1881	—0.93	—0.81	—0.12	0.0144	
1888.5	—0.82	—0.81	—0.01	0.0001	
				0.7815	

Empirical equation for determining the variation for any year: $v = 2.665 - 1.625 \sin 0.8\,(t - 1850) - 3.08 \cos 0.8\,(t - 1850)$.

Lat. 13° 05′ N. **BRIDGETOWN, BARBADOS.** Long. 59° 37′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1726......	−3.91	Mathews	Encyclopædia Metropolitana, London, 1848.
1760......	−4.50	Ross.........................	Do.
1761......	−3.78	.....do	Do.
1833......	−1.48	Philips	Phil. Trans. Royal Society, 1875.
1839......	−1.22	Milne.........................	Do.
1846......	−1.45	Schomburgh................	Do.
1882......	0.42	....	British Admiralty Chart.
1888......	1.03	Lieut. F. H. Delano, U. S. N.	Hydrographic Office, archive document.
1890.4....	1.30	E. D. Preston...............	Bulletin No. 23, United States Coast and Geodetic Survey.
1892......	0.80	Lieut. W. W. Kimball, U.S.N.	Hydrographic Office, archive document.
1893......	1.28	.....do	Do.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1726......	−3.91	−3.59	−0.32	0.1024	Probable error of a single observation = ± 15′. Period = 300 years.
1760......	−4.50	−4.29	−0.21	0.0441	
1761......	−3.78	−4.29	+0.51	0.2601	
1833......	−1.48	−1.70	+0.22	0.0484	
1839......	−1.22	−1.35	+0.13	0.0169	
1846......	−1.45	−0.95	−0.50	0.2500	
1882......	+0.42	+0.73	−0.31	0.0961	
1888......	+1.03	+0.90	+0.13	0.0169	
1890.4....	+1.30	+0.96	+0.34	0.1156	
1892......	+0.80	+0.99	−0.19	0.0361	
1893......	+1.28	+1.02	+0.26	0.0676	
				1.0542	

Empirical equation for finding the variation for any year: $v = -1.54 + 2.62 \sin 1.2 (t - 1850) + 0.812 \cos 1.2 (t - 1850)$.

Lat. 34° 36′ S. **BUENOS AYRES.** Long. 58° 22′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1829......	—13.17	D'Orbigny..................	Phil. Trans. Royal Society, 1877.
1833......	—11.67	....	
1852......	—11.75	....	
1883......	— 9.50	Lieut. Barnardières, Fr. N.	Annales Hydrographiques, 1884.

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.	
	°	°			
1829......	—13.17	—12.70	—0.47	0.2209	
1833......	—11.67	—12.45	+0.78	0.6084	Probable error of a single observation = ±38′.
1852......	—11.75	—11.55	—0.20	0.0400	Period=360 years.
1883......	— 9.50	— 9.62	+0.12	0.0144	
				0.8837	

Empirical formula for determining the variation for any year: $v = -12.032 + 3.448 \sin (t - 1850) + 0.611 \cos (t - 1850)$.

Lat. 12° 04′ S. **CALLAO, PERU.** Long. 77° 08′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1709.9......	— 6.25	Feuillée	Hansteen's Magnetismus der Erde, Christiana, 1819.
1802......	— 9.83	....	Becquerel's Traité du Magnetisme.
1823......	— 9.50		
1827......	—10.66	....	Voyages of the Adventure and Beagle, 1826-1836, London, 1839.
1835......	—10.60		
1836......	—10.40	....	Phil. Trans. Royal Society, 1877.
1838......	—10.50		
1858......	—10.66	Friesach....................	Phil. Trans. Royal Society, Part II, 1877.
1866......	—10.50	....	Phil. Trans. Royal Society, 1877.
1883......	— 9.97	Ensign Favereau, Fr. N....	Annales Hydrographiques, 2d series, 1884.
1892......	—10.00	Lieut. W. P. Conway, U.S.N.	Hydrographic information from U.S. S. Yorktown.
1893......	—10.00	Lieut. L. Mottez, Fr. N......	Annales Hydrographiques, 2d vol., 1893.

Year.	Observed	Computed.	O-C.	$\overline{O-C}^2$.	
	°	°			
1709.9......	— 6.25	— 6.32	+0.07	0.0049	
1802......	— 9.83	— 9.52	—0.31	0.0961	
1823......	— 9.50	—10.21	+0.71	0.5041	
1827......	—10.66	—10.31	—0.35	0.1225	
1835......	—10.60	—10.47	—0.13	0.0169	
1836......	—10.40	—10.49	+0.09	0.0081	Probable error of a single observation = ± 12.25′.
1838......	—10.50	—10.51	+0.01	0.0001	Period = 300 years.
1858......	—10.66	—10.60	—0.06	0.0036	
1866......	—10.50	—10.53	+0.03	0.0009	
1883......	— 9.97	—10.19	+0.22	0.0484	
1892......	—10.00	— 9.91	—0.09	0.0081	
1893......	—10.00	— 9.87	—0.13	0.0169	
				0.8306	

Empirical equation for finding the variation for any year: $v = -8.45 - 0.105 \sin 1.2 (t - 1850) - 2.16 \cos 1.2 (t - 1850)$.

Lat. 10° 25′ N. **CARTAGENA.** Long. 75° 32′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1705......	—7.20	Feuillé	Encyclopædia Metropolitana, London, 1848.
1726......	—6.83	Mathews	Do.
1801......	—7.03	Humboldt	Becquerel's Traité du Magnetisme.
1813......	—6.53	Ovington	Do.
1837......	—5.70	Milne.........................	Phil. Trans. Royal Society, 1875.
1877......	—3.96	Commander Ryan, U. S. N..	Notice to Mariners, 1877, No. 39.
1885.4....	—3.60	Lieut. S. W. Very, U. S. N..	Naval Intelligence Report from U. S. S. Tennessee.
1888.3....	—3.91	Capt. R. Boyd, U. S. N	Hydrographic Office, archive document.

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.	
	°	°			
1705......	—7.20	—6.84	—0.36	0.1296	Probable error of a single observation = ± 15.8′. Period = 300 years.
1726......	—6.83	—7.49	+0.66	0.4356	
1801......	—7.03	—7.04	+0.01	0.0001	
1813......	—6.53	—6.53	0.00	0.0000	
1837......	—5.70	—5.56	—0.14	0.0196	
1877......	—3.96	—4.11	+0.15	0.0225	
1885.4....	—3.60	—3.93	+0.33	0.1089	
1888.3....	—3.91	—3.88	—0.03	0.0009	
				0.7172	

Empirical equation for finding the variation for any year: $v = -5.81 + 1.92 \sin 1.2\,(t - 1850) + 0.794 \cos 1.2\,(t - 1850)$.

Lat. 33° 56′ S. **CAPE OF GOOD HOPE.** Long. 18° 29′ E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1605......	— 0.50	Davis........................	Voyages of the Adventure and Beagle,
1609.5....	+ 0.20	Keeling......................	Do.
1622.5....	+ 2.00	....	Walker's Terrestrial and Cosmical Magnetism.
1675.5....	+ 8.23		
1691.5....	+11.00		
1700......	+10.25	Edm. Halley................	Tabula Nautica, etc.
1751.5....	+19.25		
1775.5....	+21.23	Wales	Voyages of the Adventure and Beagle.
1788.5....	+24.08	Edm. Halley................	Tabula Nautica, etc.
1792.5....	+24.52		
1818.5....	+26.52		
1836.5....	+28.50	Fitz Roy.....................	Becquerel's Traité du Magnetisme.
1839.5....	+29.15	Edm. Halley................	Tabula Nautica, etc.
1841.5....	+29.10	Observatory	Reports of observations at Cape of Good Hope Observatory on file (1888) in library of United States Naval Observatory, Washington, D. C.
1842.5....	+29.10		
1843.5....	+29.10		
1844.5....	+29.10		
1845.5....	+29.12		
1846.5....	+29.14		
1847.5....	+29.21		
1848.5....	+29.23		
1849.5....	+29.27		
1850.5....	+29.31		
1857.5....	+29.57		
1873.9....	+30.07	Capts. Nares and Thomson, R. N.	Voyage of H. M. S. Challenger.
1890.1....	+29.53	E. D. Preston, assistant, United States Coast and Geodetic Survey.	Bulletin No. 23, United States Coast and Geodetic Survey.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1605......	— 0.50	+ 0.41	—0.91	0.8281	Probable error of a single observation = ±22.5′. Period = 590 years.
1609.5....	+ 0.20	+ 0.62	—0.42	0.1764	
1622.5....	+ 2.00	+ 1.50	+0.50	0.2500	
1675.5....	+ 8.23	+ 7.43	+0.80	0.6400	
1691.5....	+11.00	+ 9.74	+1.26	1.5876	
1700......	+10.25	+11.00	—0.75	0.5625	
1751.5....	+19.25	+19.16	+0.09	0.0081	
1775.5....	+21.23	+22.64	—1.41	1.9881	
1788.5....	+24.08	+24.31	—0.23	0.0529	
1792.5....	+24.52	+24.79	—0.27	0.0729	
1818.5....	+26.52	+27.43	—0.91	0.8281	
1836.5....	+28.50	+28.69	—0.19	0.0361	
1839.5....	+29.15	+28.84	+0.31	0.0961	
1841.5....	+29.10	+28.94	+0.16	0.0256	
1842.5....	+29.10	+28.99	+0.11	0.0121	
1843.5....	+29.10	+29.03	+0.07	0.0049	
1844.5....	+29.10	+29.08	+0.02	0.0004	
1845.5....	+29.12	+29.12	0.00	0.0000	
1846.5....	+29.14	+29.18	—0.04	0.0016	
1847.5....	+29.21	+29.20	+0.01	0.0001	
1848.5....	+29.23	+29.24	—0.01	0.0001	
1849.5....	+29.27	+29.27	0.00	0.0000	
1850.5....	+29.31	+29.30	+0.01	0.0001	
1857.5....	+29.57	+29.50	+0.07	0.0049	
1873.9....	+30.07	+29.62	+0.45	0.2025	
1890.1....	+29.53	+29.29	+0.24	0.0576	
				7.4368	

Empirical equation for determining the variation for any year: $v = 14.63 + 3.178 \sin 0.61\,(t - 1850) + 14.659 \cos 0.61\,(t - 1850)$.

Lat. 46° 14′ N. CHARLOTTETOWN, PRINCE EDWARD ISLAND. Long. 63° 08′ W

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1842.5....	+21.05	Capt. H. W. Bayfield, R. N ..	Letter of Commander Evans, R. N., hydrographer to the British admiralty, dated Jan. 5, 1866.
1851.4....	+23.03	Capt. Olebar, R. N	
1858.4....	+22.90	.....do	
1859.5....	+22.85	.....do	
1860.4....	+22.83	.....do	
1861.4....	+22.75	.....do	
1862.5....	+23.31	.....do	
1875.3....	+23 05	British officers..............	Hydrographic Office, archive document.
1876.3....	+23.53		
1879.3....	+23.90		
1880.3....	+22.82		
1881.3....	+22.92		
1882.3....	+22.85		
1883.3....	+22.88		
1886.3....	+22.70		

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.	
	°	°			
1842.5....	+21.05	+22.10	—1.05	1.166	Probable error of a single observed value = ±20′. Period = 380 years.
1851.4....	+23.03	+22.39	+0.64	0.360	
1858.4....	+22.90	+22.86	+0.04	0.000	
1859.5....	+22.85	+22.92	—0.07	0.005	
1860.4....	+22.83	+22.94	—0.11	0.012	
1861.4....	+22.75	+22.96	—0.21	0.044	
1862.5....	+23.31	+22.98	+0.33	0.109	
1875.3....	+23.05	+23.05	0.00	0.000	
1876.3....	+23.53	+23.04	+0.49	0.240	
1879.3....	+23.90	+23.00	+0.90	0.810	
1880.3....	+22.82	+22.98	—0.16	0.026	
1881.3....	+22.92	+22.96	—0.04	0.002	
1882.3....	+22.85	+22.93	—0.08	0.006	
1883.3....	+22.88	+22.91	—0.03	0.000	
1886.3....	+22.70	+22.81	—0.11	0.372	
				3.152	

Empirical equation for finding the variation for any year: $v = 15.15 + 1.714 \sin \frac{18}{19}(t - 1850) + 7.766 \cos \frac{18}{19}(t - 1850)$.

Lat. 19° 26′ N. | **CITY OF MEXICO.** | **Long. 99° 05′ W.**

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1769......	—5.47	Don Alzate..................	Hansteen's Magnetismus der Erde, 1819.
1775......	—6.70	Velasques de Leon..........	Mem. del Observatorio Met. Central de Mexico, 1880.
1803......	—8.13	Humboldt	Hansteen's Magnetismus der Erde, 1819.
1849......	—8.50	Gomez de la Cortina........	Mem. del. Observatorio Met. Central de Mexico, 1880.
1850......	—8.59	Velasques and Teran.......	Tratado de Topografia y Geodesia, Mexico, 1869.
1856......	—8.77	Müller and Sontag..........	Phil. Trans. Royal Society, 1875.
1858......	—8.37	Salazar Illaregui............	Tratado de Topografia y Geodesia, Mexico, 1869.
1860......	—8.50	Diaz Covarubias............	Do.
1862......	—8.45	Iglesias......................	Mem. del Observatorio Met. Central de Mexico, 1880.
1866.5....	—8.14	Ponce de Leon..............	Tratado de Topografia y Geodesia, Mexico, 1869.
1868......	—8.17	Fernandez..................	Do.
1879......	—8.58	....	Mem. del Observatorio Met. Central de Mexico, 1880.
1885.3....	—8.31		

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.	
	°	°			
1769......	—5.47	—6.03	+0.56	0.314	Probable error of a single observation = ± 14′. Period = 360 years.
1775......	—6.70	—6.35	—0.35	0.123	
1803......	—8.13	—7.65	—0.48	0.230	
1849......	—8.50	—8.60	+0.10	0.010	
1850......	—8.59	—8.61	—0.02	0.000	
1856......	—8.77	—8.59	—0.18	0.032	
1858......	—8.37	—8.58	+0.21	0.044	
1860......	—8.50	—8.56	+0.06	0.004	
1862......	—8.45	—8.53	+0.08	0.006	
1866.5....	—8.14	—8.47	+0.33	0.109	
1868......	—8.17	—8.45	+0.28	0.078	
1879......	—8.58	—8.21	—0.37	0.137	
1885.3....	—8.31	—8.03	—0.28	0.078	
				1.165	

Empirical equation for the determination of the variation for any year: $v = -5.52 + 0.027 \sin (t - 1850) - 3.09 \cos (t - 1850)$.

Lat. 36° 42′ S. **CONCEPCION.** Long. 73° 07′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1709	—10.33	Feuillée	Hansteen's Magnetismus der Erde, Christiana, 1819.
1792	—14.86		Brewster's Treatise on Magnetism, Edinburg, 1834.
1794	—14.86		
1821	—15.50	B. Hall	Becquerel's Traité du Magnetisme.
1823	—16.27	Duperrey	Voyage autour du Monde, Paris, 1829.
1824	—15.00	Kotzebue	Phil. Trans. Royal Society, 1877.
1825	—16.82	Beechey	
1826	—16.79	Fitz Roy	
1827	—17.03	Lütke	
1829	—16.79	King	
1835	—16.80	Fitz Roy	
1882	—17.23	Lieuts. Barnardières and Barnaud, Fr. N.	Annales Hydrographiques, 1884.
1893	—16.75	Lieut. Mottez, Fr. N.	Annales Hydrographiques, 2d vol., 1893.

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.	
	°	°			
1709	—10.33	—10.45	+0.12	0.0144	Probable error of single observation = ±23.22′. Period = 360 years.
1792	—14.86	—14.74	—0.12	0.0144	
1794	—14.86	—14.85	—0.01	0.0001	
1821	—15.50	—16.25	+0.75	0.5625	
1823	—16.27	—16.30	+0.03	0.0009	
1824	—15.00	—16.34	+1.34	1.7956	
1825	—16.82	—16.37	—0.45	0.2025	
1826	—16.79	—16.41	—0.38	0.1444	
1827	—17.03	—16.45	—0.58	0.3364	
1829	—16.79	—16.54	—0.25	0.0625	
1835	—16.80	—16.72	—0.08	0.0064	
1882	—17.23	—16.97	—0.26	0.0676	
1893	—16.75	—16.70	—0.05	0.0025	
				3.2102	

Empirical formula for determining the variation for any year: $v = -13.626 - 0.829 \sin (t - 1850) - 3.424 \cos (t - 1850)$.

Lat. 29° 57′ S. **COQUIMBO.** Long. 71° 22′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1700......	— 8.53	Feuillée	Hansteen's Magnetismus der Erde, Christiana, 1819.
1712......	—10.00	....	Brewster's Treatise on Magnetism, Edinburg, 1834.
1791.3....	—11.77		
1821......	—14.00	B. Hall	Becquerel's Traité du Magnetisme.
1828......	—14.40	Beechey	Phil. Trans. Royal Society, Part II, 1877.
1834......	—14.40	Fitz Roy......................	Voyages of Adventure and Beagle, London, 1839.
1853......	—14.59	....	French Chart No. 1746.
1870......	—14.67		
1882......	—14.35	Ensign Favereau, Fr. N......	Annales Hydrographiques, 2d series, 1884.
1883......	—13.70	Lieut. F. Hanford, U. S. N...	Naval Professional Papers, No. 19.
1889......	—13.59	Chilean astronomers	Chilean Hydrographic Notices, No. 12. 1890.
1891......	—13.63	Lieut. J. F. Moser, U. S. N., U. S. S. San Francisco.	Contributions to Terrestrial Magnetism, Hydrographic Office Publication, No. 109.

Year.	Observed.	Computed.	O–C.	$\overline{O–C}^2$.	
	°	°			
1700......	— 8.53	— 8.97	+0.44	0.1936	Probable error of a single observation = ± 21.30′. Period = 360 years.
1712......	—10.00	— 9.27	—0.73	0.5329	
1791.3....	—11.77	—12.77	+1.00	1.0000	
1821......	—14.00	—13.88	—0.12	0.0144	
1828......	—14.40	—14.06	—0.34	0.1156	
1834......	—14.40	—14.18	—0.22	0.0484	
1853......	—14.59	—14.39	—0.20	0.0400	
1870......	—14.67	—14.30	—0.37	0.1369	
1882......	—14.35	—14.09	—0.26	0.0676	
1883......	—13.70	—14.06	+0.36	0.1296	
1889......	—13.59	—13.92	+0.33	0.1089	
1891......	—13.63	—13.86	+0.23	0.0529	
				2.4408	

Empirical formula for determining the variation for any year: $v = -11.55 - 0.281 \sin (t - 1850) - 2.82 \cos (t - 1850)$.

Lat. 12° 07′ N. **CURAÇAO.** Long. 68° 57′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1704......	−6.67	Feuillée	Hansteen's Magnetismus der Erde, Christiana, 1819.
1787......	−7.00	....	Brewster's Treatise on Magnetism, Edinburg, 1834.
1819......	−5.26	Bentley..................... Givry..........................	Becquerel's Traité du Magnetisme.
1877......	−2.47	Geo. P. Ryan, U. S. N......	Notice to Mariners, 1877, No. 39.
1887......	−2.43	Lieut. Aubry, Fr. N.........	Annales Hydrographiques, 2d vol., 1888.
1888......	−2.37	Capt. R. Boyd, U. S. N..... Lieut. L. H. Delano, U. S. N.	Hydrographic Office, archive document.
1890......	−2.47	Lieut. Laird, U. S. N....... Ensign Garret, U. S. N......	Hydrographic Office Publication, No. 97.
1894......	−2.75	Lieut. W. W. Kimball, U. S. N., U. S. S. San Francisco.	Hydrographic Office Publication, No. 109.

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.			
	°	°			Wt.		
1704......	−6.67	−7.28	+0.61	0.3721	½	0.1860	Probable error of a single observation = ±13.68′. Period = 360 years.
1787......	−7.00	−6.99	−0.01	0.0001	½	0.0000	
1819......	−5.26	−5.30	−0.04	0.0016	½	0.0008	
1877......	−2.47	−2.74	+0.27	0.0729	1	0.0729	
1887......	−2.43	−2.46	+0.03	0.0009	1	0.0009	
1888......	−2.37	−2.44	+0.07	0.0049	1	0.0049	
1890......	−2.47	−2.39	−0.08	0.0064	2	0.0128	
1894......	−2.75	−2.31	−0.44	0.1936	1	0.1936	
						0.5720	

Empirical formula for determining the variation for any year: $v = -4.914 + 2.60 \sin(t - 1850) + 1.107 \cos(t - 1850)$.

Lat. 38° 32′ N. **FAYAL, AZORES.** Long. 28° 33′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1589.7....	—3.09	Wright..................	Hansteen's Magnetismus der Erde, Christiana, 1819.
1775.5....	22.12	Cook....................	Do.
1814......	23.50	Reid....................	Becquerel's Traité du Magnetisme.
1829......	25.92	Lütke	Phil. Trans. Royal Society, Part I, 1875.
1842......	27.00	Vidal...................	Do.
1890......	25.87	Lieut. J. C. Colwell, U. S. N.	Hydrographic Office Publication, No. 109.
1891......	24.50	H. M. S. Acorn..............	Letter from the British hydrographer, dated May 11, 1893.

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.	
	°	°			
1589.7....	—3.09	—2.92	—0.17	0.0289	Probable error of a single observation = ±46′. Period = 530 years.
1775.5....	22.12	21.03	+1.09	1.1881	
1814......	23.50	25.17	—1.67	2.7889	
1829......	25.92	26.04	—0.12	0.0144	
1842......	27.00	26.49	+0.51	0.2601	
1890......	25.87	25.06	+0.81	0.6561	
1891......	24.50	24.97	—0.47	0.2209	
				5.1574	

Empirical equation to determine the variation for any year: $v = 11.82 + 0.23 \sin \frac{36}{53}(t-1850) + 14.75 \cos \frac{36}{53}(t-1850)$.

Lat. 14° 36′ N. **FORT DE FRANCE.** Long. 61° 04′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1682......	—4.17	Hayes	Encyclopædia Metropolitana, 1848.
1704......	—6.15	Feuillée	Do.
1735......	—6.00	....	Brewster's Treatise on Magnetism, Edinburg, 1834.
1760......	—5.69	Ross....................	Do.
1824......	—2.78	Monnier	
1874......	—0.40	....	French Chart, No. 383.
1883.3....	+0.12	Lieut. Barnaud, Fr. N.......	French Magnetic Survey.
1887.3....	+0.28	Lieut. Aubry, Fr. N.........	Annales Hydrographiques, 2d vol., 1888.

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.	
	°	°			
1682......	—4.17	—4.08	—0.09	0.0081	Probable error of a single observed value = ±19′. Period = 330 years.
1704......	—6.15	—5.19	+0.96	0.9216	
1735......	—6.00	—6.00	0.00	0.0000	
1760......	—5.69	—5.84	+0.15	0.0225	
1824......	—2.78	—2.77	—0.01	0.0001	
1874......	—0.40	—0.06	—0.34	0.1156	
1883.3....	+0.12	+0.24	—0.12	0.0144	
1887.3....	+0.28	+0.34	—0.06	0.0036	
				1.0859	

Empirical equation for determining the variation for any year: $v = -2.726 + 29.26 \sin \frac{12}{11}(t-1850) + 1.528 \cos \frac{12}{11}(t-1850)$.

Lat. 1° S. **GALAPAGOS ISLANDS.** Long. 90° W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1794......	— 8.00	Vancouver	Voyages of the Adventure and Beagle.
1821......	— 8.33	B. Hall	Do.
1835......	— 9.50	Fitz Roy	Do.
1846......	— 8.83	Kellet	Phil. Trans. Royal Society, 1877.
1852......	—10.30	German Mag. Survey	Annalen der Hydrographie.
1874.5....	— 8.83	—8.83. 1873 .... —8.83. 1876	B. A. Chart, No. 1375. Annalen der Hydrographie.
1880......	— 8.75	....	B. A. Variation Chart, No. 2598.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1794......	— 8.00	—7.76	—0.24	0.0576	Probable error of a single observation = ± 25′. Period = 240 years.
1821......	— 8.33	—8.92	+0.59	0.3481	
1835......	— 9.50	—9.28	—0.22	0.0484	
1846......	— 8.83	—9.40	+0.57	0.3249	
1852......	—10.30	—9.39	—0.91	0.8281	
1874......	— 8.83	—9.00	+0.17	0.0289	
1880......	— 8.75	—8.69	—0.06	0.0036	
				1.6396	

Empirical equation for determining the variation for any year: $v = -7.491 + 0.069 \sin 1.5\,(t - 1850) - 1.91 \cos 1.5\,(t - 1850)$.

Lat. 44° 39.6′ N. **HALIFAX, NOVA SCOTIA.** Long. 63° 35.3′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1700......	13.00	....	Edmund Halley's Isogonic Chart for 1700.
1756......	12.83	....	United States map, by Chas. Morris.
1775......	13.60	....	Des Barres's Sailing Directions.
1798......	16.50	....	Plan published by Thos. Backhouse.
1818......	17.47	Anthony Lockwood, esq	Remark book of J. Napier, R. N.
1821......	17.60	J. Napier, R. N...............	Do.
1852.5....	18.50	Capt. Bayfield, R. N.......... J. Hill, R. N	Remark book by J. Hill, master, R. N.
1860......	19.91	Capt. Orlebar, R. N	
1866......	21.10	....	From records of Halifax dockyard.
1879......	20.71	J. Baylor, United States Coast and Geodetic Survey.	Coast and Geodetic Survey Report for 1881, Appendix No. 9.

Year.	Observed.	Computed.	O-C.	$\overline{O.C}^2$.	
	°	°			
1700......	13.00	12.83	+0.17	0.0289	Probable error of a single observed value = ±26′. Period = 350 years.
1756......	12.83	13.12	—0.29	0.0841	
1775......	13.60	14.11	—0.51	0.2601	
1798......	16.50	15.70	+0.80	0.6400	
1818......	17.47	17.24	+0.23	0.0529	
1821......	17.60	17.47	+0.13	0.0169	
1852.5....	18.50	19.63	—1.13	1.2769	
1860......	19.91	20.03	—0.12	0.0144	
1866......	21.10	20.31	+0.79	0.6241	
1879......	20.71	20.77	—0.06	0.0036	
				3.0019	

Empirical equation for determining the variation for any year: $v = 16.74 + 3.32 \sin \frac{36}{35}(t-1850) + 2.74 \cos \frac{36}{35}(t-1850)$.

Lat. 23° 09′ N. **HABANA, CUBA.** Long. 82° 22′ E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1726	−4.40	Mathews	Encyclopædia Metropolitana, 1848.
1732.3	−4.50	Harris	Do.
1815	−7.00		Encyclopædia Britannica, 7th ed., 1842.
1816.5	−5.50	Bentley	Do.
1840	−5.67	Lavallée	Becquerel's Traité du Magnetisme.
1857	−5.27	United States Coast Survey. Friesach	Sabine's Collection, Phil. Trans. Royal Society, 1875.
1858	−5.75		From a map of Cuba, 1860.
1874.5	−4.28	Benito Viñes	Observaciones Magneticas and Meterologicas de Real Colegio de Belen, 1st semestre, 1876.
1879.2	−3.90	Lieut. Com. Ackley, U. S. N.	
1885.3	−3.68	Benito Viñes	Observaciones Magneticas and Meterologicas de Real Colegio de Belen.
1887	−3.62		Do.
1888.3	−3.61	Benito Viñes	Do.
1889.3	−3.57	.....do	Do.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1726	−4.40	−4.22	−0.18	0.0324	Probable error of a single observed value = ± 17′. Period = 360 years.
1732.3	−4.50	−4.55	+0.05	0.0025	
1815	−7.00	−6.47	−0.53	0.2809	
1816.5	−5.50	−6.46	+0.96	0.9216	
1840	−5.67	−5.87	+0.20	0.0400	
1857	−5.27	−5.19	−0.08	0.0064	
1858	−5.75	−5.14	−0.61	0.3721	
1874.5	−4.28	−4.32	+0.04	0.0016	
1879.2	−3.90	−4.08	+0.18	0.0324	
1885.3	−3.68	−3.98	+0.30	0.0900	
1887	−3.62	−3.65	+0.03	0.0009	
1888.3	−3.61	−3.59	−0.02	0.0004	
1889.3	−3.57	−3.53	−0.04	0.0016	
				1.7828	

Empirical equation for determining the variation for any year: $v = -3.42 + 2.36 \sin(t - 1850) - 2.07 \cos(t - 1850)$.

Lat. 22° 16′ N. **HONGKONG, CHINA.** Long. 114° 10′ E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1780......	+0.50	Cook........................	Hansteen's Magnetismus der Erde, Christiana, 1819.
1792......	—1.28	....	Brewster's Treatise on Magnetism, Edinburg, 1837.
1824......	—1.70	Bougainville	Becquerel's Traité du Magnetisme.
1827......	—2.00	Beechey	Phil. Trans. Royal Society, Part I, 1875.
1830......	—1.58	Laplace.......................	Do.
1837......	—1.08	Darandian....................	Do.
1843......	—0.62	Belcher.......................	Do.
1855......	—0.50	Richards	Observations and Researches at Hongkong, by M. Dorbeck.
1875......	—0.93		
1876......	—0.60	....	Annales Hydrographiques, 1876.
1884......	—0.77	....	Observations and Researches made at Hongkong, by M. Dorbeck.
1885.5....	—0.75		
1887.5....	—0.70	Dorbeck......................	Hongkong, Government Gazette, May 31, 1888.

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.			
	°	°			*Wts.*		
1780......	+0.50	—0.48	+0.98	0.9604	¼	0.2401	Probable error of a single observation = ±15′. Period = 450 years.
1792......	—1.28	—0.70	—0.58	0.3364	¼	0.0841	
1824......	—1.70	—1.06	—0.64	0.4096	½	0.2048	
1827......	—2.00	—1.08	—0.92	0.8464	¼	0.2116	
1830......	—1.58	—1.08	—0.50	0.2500	½	0.1250	
1837......	—1.08	—1.09	+0.01	0.0001	½	0.0001	
1843......	—0.62	—1.08	+0.46	0.2116	1	0.2116	
1855......	—0.50	—1.03	+0.53	0.2809	1	0.2809	
1875......	—0.93	—0.80	—0.13	0.0169	1	0.0169	
1876......	—0.60	—0.79	+0.19	0.0361	1	0.0361	
1884......	—0.77	—0.65	—0.12	0.0144	1	0.0144	
1885.5....	—0.75	—0.62	—0.13	0.0169	1	0.0169	
1887.5....	—0.70	—0.59	—0.11	0.0121	1	0.0121	
						1.4546	

Empirical equation for determining the variation for any year: $v = 0.990 + 0.389 \sin 0.8\,(t - 1850) - 2.047 \cos 0.8\,(t - 1850)$.

Lat. 10° 36′ N. **LA GUAYRA.** Long. 66° 56.5′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1800......	−4.35	Humboldt	Becquerel's Traité du Magnetisme.
1814......	−4.88	Forley........................	Do
1820......	−4.17	Givry..........................	Do
1877.3....	−2.40	Commander G. P. Ryan, U. S. N.	Notice to Mariners, 1877, No. 39.
1883.2....	−2.48	Lieut. Barnaud, Fr. N........	Annales Hydrographiques, 2d series, 1884.
1888.1....	−2.25	Commander O. F. Heyerman, U. S. N.	Hydrographic Office, archive document.
1890.1....	−2.85	Lieut. Laird, U. S. N......... Ensign Garret. U. S. N......	Hydrographic Office Publication, No. 97, Telegraphic Determinations of Longitude in the West Indies and Central and South America, 1888 and 1889.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1800......	−4.35	−5.05	+0.70	0.4900	Probable error of a single observation = ± 21′. Period = 360 years.
1814......	−4.88	−4.38	−0.50	0.2500	
1820......	−4.17	−4.25	+0.08	0.0064	
1877.3....	−2.40	−2.68	+0.28	0.0784	
1883.2....	−2.48	−2.53	+0.05	0.0025	
1888.1....	−2.25	−2.42	+0.17	0.0189	
1890.1....	−2.85	−2.38	−0.47	0.2209	
				1.0671	

Empirical equation for determining the variation for any year: $v = -3.382 + 1.623 \sin (t-1850) - 0.0659 \cos (t-1850)$.

Lat. 28° 15′ N. **LAGOON HEAD, MEXICO.** Long. 114° 06′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1783......	— 8.42	Spanish navigators.........	Coast and Geodic Survey Appendix, No. 1, Report for 1888.
1839......	—10.90	....	
1842.5....	—11.10	....	
1873......	—11.85	W. Eimbeck, assistant, Coast and Geodetic Survey.	Hydrographic Office, archive document.
1881......	—12.10	....	
1888......	—11.52	Pond	Do.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1783......	— 8.42	— 8.41	—0.01	0.0001	Probable error of a single observation = ± 09′. Period = 252 years.
1839......	—10.90	—10.95	+0.05	0.0025	
1842.5....	—11.10	—11.10	0.00	0.0000	
1873......	—11.85	—11.82	—0.03	0.0009	
1881......	—12.10	—11.83	—0.27	0.0729	
1888......	—11.52	—11.78	+0.26	0.0676	
				0.1440	

Empirical equation for determining the variation for any year: $v = -9.845 - 1.289 \sin \frac{10}{7} (t-1850) - 1.519 \cos \frac{10}{7} (t-1850)$.

Lat. 24° 38′ N. **MAGDALENA BAY, LOWER CALIFORNIA.** Long. 112° 07′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1783.3....	— 6.78	Spanish navigators..........	Coast and Geodetic Survey Appendix, No. 1, Report for 1888, p. 273.
1837......	— 8.28	La Venus....................	Phil. Trans. Royal Society, 1875.
1839......	— 9.25	Belcher.....................	Do.
1866......	—10.68	Harkness....................	Smithsonian Contributions to Knowledge.
1871.3....	—11.00	G. Bradford, assistant, Coast and Geodetic Survey.	Chart in Coast Survey archives.
1873.3....	—10.56	W. Eimbeck, assistant, Coast and Geodetic Survey. Commander G. Dewey, U. S. N.	Appendix, No. 13, Coast and Geodetic Survey, Rep., 1882.
1881.2....	—10.48	Lieut. Commander H. E. Nichols, U. S. N.	Coast and Geodetic Survey Appendix, No. 7, Report for 1888, p. 273.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$	
	°	°			
1783.3....	— 6.78	— 5.77	—1.01	1.020	Probable error of a single observation = ± 35′. Period = 252 years.
1837......	— 8.28	— 9.54	+1.26	1.588	
1839......	— 9.25	— 9.72	+0.47	0.221	
1866......	—10.68	—10.58	—0.10	0.010	
1871.3....	—11.00	—10.59	—0.41	0.168	
1873.3....	—10.56	—10.58	+0.02	0.000	
1881.2....	—10.48	—10.47	—0.01	0.000	
				3.007	

Empirical equation for determining the variation for any year: $v = -7.484 - 1.469 \sin \frac{10}{7} (t-1850) - 2.739 \cos \frac{10}{7} (t-1850)$.

Lat. 14° 36′ N. **MANILA, LUZON ISLAND.** Long. 120° 58′ E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1766	+0.25	Le Gentil	Hansteen's Magnetismus der Erde, Christiana, 1819.
1792.6	—0.29		Brewster's Treatise on Magnetism, Edinburg, 1834.
1829.5	—0.58	Lütke, 1829, 0.°17 Laplace, 1830, 1°	Phil. Trans. Royal Society, Part I, 1875.
1836	—0.50	Bonites	Do.
1844	—0.30	Belcher	Do.
1887	—0.83	Local authority	
1887 *	—1.00	U. S. S. Essex	Hydrographic Office, archive document.
1890	—0.80	Observatory	Report of Observatorio Meteorologico de Manila, 1890.

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.	Wt.		
	°	°					
1766	+0.25	+0.13	+0.12	0.0144	1	0.0144	Probable error of a single observation = ± 08.3′. Period = 360 years.
1792.6	—0.29	—0.11	—0.18	0.0324	1	0.0324	
1829.5	—0.58	—0.47	—0.11	0.0121	2	0.0242	
1836	—0.50	—0.53	+0.03	0.0009	2	0.0018	
1844	—0.30	—0.60	+0.30	0.0900	1	0.0900	
1887	—0.83	—0.80	—0.03	0.0009	3	0.0027	
1890	—0.80	—0.80	+0.00	0.0000	3	0.0000	
						0.1655	

* Omitted in investigation.

Empirical equation for determining the variation for any year: $v = -0.223 - 0.399 \sin (t - 1850) - 0.418 \cos (t - 1850)$.

Lat. 34° 54′ S.

MONTEVIDEO.

Long. 56° 12′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1789.7	−13.67		Brewster's Treatise on Magnetism, Edinburg, 1834.
1807	−13.33	Beaufort	Becquerel's Traité du Magnetisme.
1820	−12.78	Freycinet	Do.
1826*	−10.39	Fitz Roy	Voyages of the Adventure and Beagle.
1827	−12.12	King	Phil. Trans. Royal Society, Part II, 1877.
1829	−11.72	D'Orbigny	Do.
1830	−11.70	Duperrey	Do.
1834.5	−11.62	Fitz Roy, 1833, −12°.66. Bonite, 1836, −10°.59.	Do.
1843.5	−10.70	Sullivan	Do.
1844.6	−10.88		
1852	−10.22	Macrae	Do.
1866	−9.35	Harkness	Do.
1882.6	−8.23	Lieuts. Barnaud and Barnardières.	Annales Hydrographiques, 1884.
1883*	−7.90	Lieut. H. W. Lyon, U. S. N.	Naval Professional Papers, No. 19, p. 139.
1888.4	−7.32	Lieut. Davenport, U. S. N.	Hydrographic Office Publication, No. 109.
1893.2	−7.62	Lieut. Blocklinger, U. S. N., Jan., 1893, −8.27. Lieut. Mottez, Fr. N., May 1893, −6.97.	Do. Annales Hydrographiques, 2d vol., 1893.
1894.3	−7.67	Lieut. J. H. Bull, U. S. N.	Hydrographic Office, archive document.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1789.7	−13.67	−14.11	0.44	0.1936	Probable error of a single observation = ±12.34′. Period = 360 years.
1807	−13.33	−13.02	−0.31	0.0961	
1820	−12.78	−12.33	−0.55	0.3025	
1827	−12.12	−11.91	−0.21	0.0441	
1829	−11.72	−11.78	+0.06	0.0036	
1830	−11.70	−11.72	+0.02	0.0004	
1834.5	−11.62	−11.44	−0.18	0.0324	
1843.5	−10.70	−10.84	+0.14	0.0196	
1844.6	−10.88	−10.76	−0.12	0.0144	
1852	−10.22	−10.27	+0.05	0.0025	
1866	−9.35	−9.32	−0.03	0.0009	
1882.6	−8.23	−8.28	+0.05	0.0025	
1888.4	−7.32	−7.95	+0.63	0.3969	
1893.2	−7.62	−7.70	+0.08	0.0064	
1894.3	−7.67	−7.64	−0.03	0.0009	
				1.1168	

* Omitted in investigation.

Empirical equation for determining the variation for any year: $v = -10.28 + 3.9 \sin(t - 1850) - 0.119 \cos(t - 1850)$.

Lat. 32° 43′ N. **NAGASAKI BAY, JAPAN.** Long. 129° 51′ E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1805......	1.76	Krusenstern................	Becquerel's Traité du Magnetisme.
1845......	2.58	Belcher......................	Phil. Trans. Royal Society, 1875.
1884.5....	3.75	Commander Barclay, U. S. N.	Hydrographic Office, archive document.
1888.8....	3.56	Japanese hydrographer.....	Do.
1891.5....	3.78	Lieut. De Roujon, 1891, 3.63 Lieut. De Roujon, 1892, 3.93	Annales Hydrographiques, 1st vol., 1892.
1892.4....	3.82	Local authority.............	Hydrographic Office, archive document.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1805......	1.76	1.76	0.00	0.0000	Probable error of a single observation = + 05.1′.
1845......	2.58	2.63	—0.05	0.0025	
1884.5....	3.75	3.59	+0.16	0.0256	
1888.8....	3.56	3.70	—0.14	0.0196	
1891.5....	3.78	3.75	+0.03	0.0009	
1892.4....	3.82	3.82	0.00	0.0000	
				0.0486	

Empirical formula for determining the variation for any year: $v = 2.74 + 0.0237 (t - 1850) + 0.0000774 (t - 1850)^2$.

Lat. 23° 39′ S. **NOSY VÉ.** Long. 43° 36′ E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1607.2....	15.47	Keeling.......................	Hansteen's Magnetismus der Erde, 1819.
1611.3....	15.28	14.83, Davis, 1610............ 15.18, Saris, 1611............ 15.66, Payton, 1613..........	Do.
1721......	23.80	Mathews.....................	Do.
1770.5....	23.60	22.50, Beauvais, 1770........ 24.70, Nicholson, 1771.......	Annales Hydrographiques, 2d series, 1st vol., 1893.
1824.5....	20.47	20.13, Owen, 1824........... 20.80, Owen, 1825...........	Do. Phil. Trans. Royal Society, 1877.
1858......	19.00	F. de Langle.................	Annales Hydrographiques, 2d series, 1st vol., 1893.
1866......	19.00	Fournier.....................	Do.
1889.7....	17.47	Mion.........................	Do.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1607.2....	15.47	15.37	+0.10	0.0100	Probable error of a single observation = ± 30′. Period = 600 years.
1611.3....	15.28	15.71	—0.43	0.1849	
1721......	23.80	23.03	+0.77	0.5929	
1770.5....	23.60	23.52	+0.08	0.0064	
1824.5....	20.47	21.60	—1.13	1.2769	
1858......	19.00	19.34	—0.34	0.1156	
1866......	19.00	18.70	+0.30	0.0900	
1889.7....	17.47	16.77	+0.70	0.4900	
				2.7667	

Empirical equation for the determination of the variation for any year: $v = 15.31 - 6.883 \sin 0.6 (t - 1850) + 4.629 \cos 0.6 (t - 1850)$.

Lat. 8° 57′ N. **PANAMA.** Long. 79° 32′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1775.9....	—7.80	....	Encyclopædia Britannica, 7th edition, 1842.
1790.8....	—7.80	Don A. Malaspina............	Berliner Astronomische Jahrbuch, vol. 53, 1828, p. 188.
1802......	—8.00	....	Encyclopædia Britannica, 7th edition, 1842.
1822......	—7.00	B. Hall......................	Becquerel's Traité du Magnetisme, 1846.
1837......	—7.00	Belcher......................	Phil. Trans. Royal Society, 1875.
1849......	—7.01	Emory........................	Do.
1858......	—6.30	Friesach.....................	Do.
1866.4....	—5.90	Harkness.....................	Do.
1883.2....	—5.03	Lieut. Barnaud, Fr. N.......	Annales Hydrographiques, 2d series, 1884.
1885......	—5.25	Lieut. Commander W. Welch	Hydrographic Office Publication, No. 109, Contributions to Terrestrial Magnetism.

Year.	Observed.	Computed.	O–C	$\overline{O-C}^2$.	
	°	°			
1775.9....	—7.80	—7.60	—0.20	0.0400	Probable error of a single observation = ± 13′. Period = 200 years.
1790.8....	—7.80	—7.78	—0.02	0.0004	
1802......	—8.00	—7.90	—0.10	0.0100	
1822......	—7.00	—7.52	+0.52	0.2704	
1837......	—7.00	—6.99	—0.01	0.0001	
1849......	—7.01	—6.48	—0.53	0.2809	
1858......	—6.03	—6.10	+0.07	0.0049	
1866.4....	—5.90	—5.77	—0.13	0.0169	
1883.2....	—5.03	—5.31	+0.28	0.0784	
1885......	—5.25	—5.27	+0.02	0.0004	
				0.7024	

Empirical equation for determining the variation for any year: $v = -6.540 + 1.367 \sin 1.8\,(t - 1850) + 0.105 \cos 1.8\,(t - 1850)$.

Lat. 5° 05′ S.

PAYTA, PERU.

Long. 81° 05.5′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1821	−9.00	B. Hall	Becquerel's Traité du Magnetisme.
1823.2	−8.93		Sabine's Collection. Phil. Trans. Royal Society, 1877.
1835	−9.00		
1836	−9.00		
1866	−8.88		
1880	−8.67		B. A. variation chart for 1880.
1883	−8.23	Lieut. Barnaud, Fr. N	Annales Hydrographiques, 2d series, 1884.
1884.1	−8.47	Lieut. J. F. Miller	Hydrographic Office Publication, No. 109, Contributions to Terrestrial Magnetism.
1891.3	−8.80	Lieut. J. F. Moser, U. S. N.	Hydrographic Office, archive document.
1892.9	−8.27	Lieut. Mottez, Fr. N	Annales Hydrographiques, 2d vol., 1893.
1894.2	−7.52	Lieut. Fichbohm, U. S. N.	Hydrographic Office Publication, No. 109, Contributions to Terrestrial Magnetism.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1821	−9.00	−9.11	+0.11	0.0121	Probable error of a single observed value = ±14.22′. Period = 300 years.
1823.2	−8.93	−9.12	+0.19	0.0361	
1835	−9.00	−9.18	+0.18	0.0324	
1836	−9.00	−9.18	+0.18	0.0324	
1866	−8.88	−8.82	−0.06	0.0036	
1880	−8.67	−8.44	−0.23	0.0529	
1883	−8.23	−8.36	+0.13	0.0169	
1884.1	−8.47	−8.32	−0.15	0.0225	
1891.3	−8.80	−8.08	−0.72	0.5184	
1892.9	−8.27	−8.05	−0.22	0.0484	
1894.2	−7.52	−7.98	+0.46	0.2116	
				0.9873	

Empirical equation for determining the variation for any year: $v = -7.417 + 0.556 \sin 1.2\,(t - 1850) - 1.67 \cos 1.2\cdot(t - 1850)$.

Lat. 39° 54′ N. **PEKING.** Long. 116° 28′ E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1755......	+2.00	Amiot....................	Hansteen's Magnetismus der Erde, 1819.
1831......	1.80	Faus....................	Phil. Trans. Royal Society, 1875.
1835......	2.17	Kowanko....................	Do.
1868......	2.42	Fritsche....................	Do.
1875......	2.50		Erganzurgshift zu Petermann Mittheilungen, 1884–85.
1886.9....	2.90	Lieut. J. E. Roller, U. S. N., U. S. S. Palos.	Hydrographic Office Publication, No. 109.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1775......	2.00	1.99	+0.01	0.0001	Probable error of a single observation = ± 06′.
1831......	1.80	1.97	−0.17	0.0289	
1835......	2.17	2.01	+0.16	0.0256	
1868......	2.42	2.45	−0.03	0.0009	
1875......	2.50	2.50	0.00	0.0000	
1886.9....	2.90	2.82	+0.08	0.0064	
				0.0683	

Empirical equation for determining the variation for any year: $v = 2.179 + 0.0131 (t - 1850) + 0.00117 (y - 1850)^2$.

Lat. 8° 03′ S. **PERNAMBUCO.** Long. 34° 52′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1815......	3.00	Hawett....................	Becquerel's Traité du Magnetisme.
1819......	4.75	Roussin....................	Do.
1822......	4.80	Owen....................	Do.
1836......	5.90	Fitz Roy....................	Voyages of the Adventure and Beagle, 1826–36.
1865......	11.00	Harkness....................	Phil. Trans. Royal Society, 1877.
1867......	11.00	Admiral Mouchez, Fr. N....	French Chart.
1872......	11.50	....	French Chart, No. 2748, Pub. 1868, Cor. 1873–75.
1881......	12.91	Dr. Van Ryckworsel and E. Engelenburg.	Magnetic Survey of the Eastern Part of Brazil, published by the Royal Academy of Sciences, Amsterdam, 1890.
1892......	14.40	Capt. H. M. Franck..........	Hydrographic Office, archive document.
1894.2....	14.50	Lieut. J. C. Cresap, U. S. S. Bennington.	Hydrographic Office Publication, No. 109.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1815......	3.00	3.60	−0.60	0.3600	Probable error of a single observation = ±17.4′. Period = 400 years.
1819......	4.75	4.10	+0.65	0.4225	
1822......	4.80	4.48	+0.32	0.1024	
1836......	5.90	6.41	−0.51	0.2601	
1865......	11.00	10.67	+0.33	0.1089	
1867......	11.00	10.97	+0.03	0.0009	
1872......	11.50	11.69	−0.19	0.0361	
1881......	12.91	12.94	−0.03	0.0009	
1892......	14.40	14.36	+0.04	0.0016	
1894.2....	14.50	14.63	−0.13	0.0169	
				1.3103	

Empirical equation for determining the variation for any year: $v = 8.994 + 9.451 \sin 0.9 (t - 1850) - 0.539 \cos 0.9 (t - 1850)$.

Lat. 53° 01′ N. **PETROPAULOWSKI, SIBERIA.** Long. 158° 43′ E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1779.5	−6.30	Capt. J. King	A Voyage to the Pacific Ocean, London, 1784.
1792	−6.00	G. Sarycheff	F. P. Lütke's Voyage around the World, St. Petersburg, 1835.
1804.7	−5.49	A. J. von Krusenstern	Voyage around the World, London, 1813.
1827.6	−4.07	Capt. F. W. Beechey, 4.22 Capt. F. P. Lütke, 3.72 A. G. Erman, 4.10	Narrative of a Voyage to the Pacific, 1825–28, London, 1831. Lenz in Mem. St. Peters. Acad. Sc., vol. 1, 1838. Reise um die Erde, Berlin, 1835.
1837.7	−3.45	Du Petit Thouars	Voyage autour du Monde, Paris, 1843.
1849.5	−2.61	Capt. H. Kellett	Gen. Sir Edw. Sabine in Phil. Trans. Roy. Soc., vol. 162, London, 1872.
1854.6	−2.59	Frigate Aurora	Compt-rendu annuel de l'Observatoire Phys. Cent. de Russia, année, 1854.
1866	−1.41	K. S. Staritzky	Onazevich's collection of observations made during hydrographic explorations in the Pacific, 1874–77.
1876	−1.15	M. S. Onazevich	Reference as above for 1866.
1891	+0.83	Prof. Stellingman, 1890, +.52 Lieut. Lachton, Rus. N., 1892, +1.16.	Hydrographic Office, archive document.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1779.5	−6.30	−5.97	−0.33	0.1089	Probable error of a single observation = ± 21.3′. Period = 252 years.
1792	−6.00	−6.00	0.00	0.0000	
1804.7	−5.49	−5.70	+0.21	0.0441	
1827.6	−4.07	−4.44	+0.37	0.1369	
1837.7	−3.45	−3.68	+0.23	0.0529	
1849.5	−2.61	−2.70	+0.09	0.0081	
1854.6	−2.59	−1.63	−0.96	0.9216	
1866	−1.41	−1.37	−0.04	0.0016	
1876	−1.15	−0.65	−0.50	0.2500	
1891	+0.83	+0.18	+0.65	0.4225	
				1.9466	

Empirical equation for the determination of the variation for any year: $v = -2.682 + 3.349 \sin \frac{10}{7}(t-1850) + 0.0156 \cos \frac{10}{7}(t-1850)$.

Lat. 2° 45′ S. Puna.
Lat. 2° 13′ S. Guayaquil.

PUNA AND GUAYAQUIL.

Long. 79° 52′ W.

Year.	Variation of compass.	Authority.	
		Observer	Where recorded.
	°		
1791......	—9. 18	....	Brewster's Treatise on Magnetism, Edinburg.
1822......	—9. 01	B. Hall........................	Becquerel's Traité du Magnetisme.
1835......	—8. 75	Fitz Roy, 8.50° E............ Fitz Roy, 9° E..............	Phil. Trans. Royal Soc., 1877.
1836......	—8. 45	Bonite.......................	Do.
1838......	—8. 93	Belcher......................	Do.
1880......	—8. 00	....	B. A. variation chart, No. 2598.

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.	
	°	°			
1791......	—9. 18	—9. 23	+0. 05	0. 0925	Probable error of a single observation = ± 10′.
1822......	—9. 01	—8. 94	—0. 07	0. 0049	
1835......	—8. 75	—8. 74	—0. 01	0. 0001	
1836......	—8. 45	—8. 72	+0. 27	0. 0729	
1838......	—8. 93	—8. 69	—0. 24	0. 0576	
1880......	—8. 00	—7. 77	—0. 23	0. 0529	
				0. 1909	

Empirical equation for determining the variation for any year: $v = -8.459 + 0.0201\,(t - 1850) + 0.0001\,(t - 1850)^2$.

Lat. 53° 10′ S. **PUNTA ARENAS.** Long. 70° 54′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1766*	−22.43	22.50, Wallis, 1766............ 22.36, Carteret, 1766..........	Voyage of the Adventure and Beagle, 1826–36, London, 1839
1828*	−23.33	King...........................	Becquerel's Traite du Magnetisme.
1831*	−22.83	Fitz Roy......................	Voyage of Adventure and Beagle, London, 1839.
1866......	−21.87	Harkness.....................	Smithsonian Contributions to Knowledge, No. 239, 1873.
1872*	−21.83	....	British Admiralty Chart, No. 547.
1883......	−20.97	20.75	British Admiralty Chart, No. 545.
		21.18, Brazilian Transit of Venus Commission.	Ann. de l'Obso. Imp. de Rio de Janeiro.
1893.3....	−20.17	Lieut. L. Mottez, Fr. N......	Annales Hydrographiques, 2d vol., 1893.

Year.	Observed.	Computed.	C–C.	$\overline{O-C}^2$.	
	°	°			
1766......	−22.43	−21.82	−0.61	0.3721	Probable error of a single observation = ±16 6′. Period = 360 years.
1828......	−23.33	−23.73	+0.40	0.1600	
1831......	−22.83	−23.67	+0.16	0.0256	
1866......	−21.87	−22.12	+0.25	0.0625	
1872......	−21.83	−21.69	−0.14	0.0196	
1883......	−20.97	−20.85	−0.12	0.0144	
1893.3....	−20.17	−19.99	−0.18	0.0324	
				0.6866	

---

* Taken at Port Famine.

Empirical equation for determining the variation for any year: $v = -18.68 + 2.71 \sin (t - 1850) - 4.35 \cos (t - 1850)$.

Lat. 22° 54′ S. **RIO DE JANEIRO.** Long. 43° 10′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1768......	—7.57	Cook	Voyage of the Adventure and Beagle, London, 1839.
1783.5....	—6.60	....	Anuario Hidrografico de Chile, Año XII.
1787......	—6.20	Hunter	Voyage of the Adventure and Beagle, London, 1839.
1820.5....	—3.66	—3.57, Freycinet, 1820 ...... —3.70, Rumkert and Bellinghausen, 1821,	Becquerel's Traité du Magnetisme.
1824.5....	2.93	—3.00, Owen, 1822........... —3.12, Beechey, 1825........ —2.62, King, 1826...........	Do.
1833......	—2.04	—2.13, Ermann, 1830 .... —2.00, Fitz Roy, 1836.......	Reise um die Erde, etc., Berlin, 1835. Voyage of Adventure and Beagle, London, 1839.
1851.9....	—1.25	....	Annalen der Hydrographie, 1877.
1857......	+1.33	Stormley and Richards	British Admiralty Chart, No. 541.
1866......	+2.70	Harkness....................	Smithsonian Contributions to Knowledge, 1873.
1876.5....	+4.43	Lieut. S. W. Very, U. S. N...	Appendix No. 7 to Coast and Geodetic Survey Report for 1888.
1882.6....	+4.65	Lieuts. Barnardières and Barnaud, Fr. N.	French Magnetic Survey. Annales Hydrographiques, 1884.
1885......	+5.33	Cruls	Anuario Hidrografico de Chile, Año XII.
1887.7....	+5.95	Lieut. de Roujon, Fr. N.....	Annales Hydrographiques, 1888.

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.	
	°	°			
1768......	—7.57	—7.01	—0.56	0.3136	Probable error of a single observation = ± 26′, Period = 360 years.
1783.5....	—6.60	—6.85	+0.25	0.0625	
1787......	—6.20	—6.73	+0.53	0.2809	
1820.5....	—3.66	—4.03	+0.37	0.1369	
1824.5....	—2.93	—3.56	+0.63	0.3969	
1833......	—2.04	—2.46	+0.42	0.1764	
1851.9....	—1.25	+0.28	—1.53	2.3409	
1857......	+1.33	+1.06	+0.27	0.0729	
1866......	+2.70	+2.45	+0.25	0.0625	
1876.5....	+4.43	+4.04	+0.39	0.1521	
1882.6....	+4.65	+4.94	—0.29	0.0841	
1885......	+5.33	+5.29	+0.04	0.0016	
1887.7....	+5.95	+5.67	+0.28	0.0784	
				4.1597	

Empirical equation for determining the variation for any year: $v = 1.814 + 8.655 \sin (t - 1850) - 1.825 \cos (t - 1850)$.

Lat. 47° 34′ N. **ST. JOHNS, NEWFOUNDLAND.** Long. 52° 41′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1844.8....	29.60	....	Letter to United States Coast and Geodetic Survey from Commander F. J. Evans, R. N., hydrographer to the British admiralty.
1857.5....	31.35	....	
1862.7....	31.33	....	
1863.7....	31.30	....	
1864.5....	31.00	....	
1866.5....	30.91	....	
1881.7....	30.62	Lieut. S. W. Very, U. S. N ...	Coast Survey Report, 1882, App. 12.
1884.5....	30.33	Lieut U. Sebree, U. S. N	Naval Professional Papers, No. 19.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1844.8....	29.60	29.90	—0.30	0.0900	Probable error of a single observation = ±17.4′. Period = 360 years.
1857.5....	31.35	30.67	+0.68	0.4624	
1862.7....	31.33	30.90	+0.43	0.1849	
1863.7....	31.30	30.92	+0.38	0.1444	
1864.5....	31.00	30.92	+0.08	0.0064	
1866.5....	30.91	30.95	—0.04	0.0016	
1881.7....	30.62	30.71	—0.09	0.0081	
1884.5....	30.33	30.51	—0.18	0.0324	
				0.9302	

Empirical equation for determining the variation for any year: $v = 15.634 + 4.80 \sin (t - 1850) + 14.76 \cos (t - 1850)$.

Lat. 21° 32′ N. **SAN BLAS, MEXICO.** Long. 105° 19′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1783......	—5.00	....	Report Superintendent of Coast and Geodetic Survey, 1886, plate No. 30.
1791.25...	—7.43	Malaspina	Berliner Ast. Jahrbuch, vol. 53, 1828.
1821......	—8.67	Hall	Encyclopædia Britannica, 7th ed.
1837......	—8.85	8.57, Sir Edw. Belcher ...... 9.15, Du Petit Thouars......	Phil. Trans. Royal Society, 1843.
1838......	—8.78	Belcher	Do.
1839......	—9.00		
1841......	—9.20	Duflot de Mofras	Duflot de Mofras's Exploration of Oregon, 1844.
1874......	—9.10	Dewey.....................	Survey by U. S. S. Narragansett.
1880......	—9.30	Nichols	App. No. 13, United States Coast and Geodetic Survey Report, 1882.

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.	
	°	°			
1783......	—5.00	—5.97	+0.97	0.9409	Probable error of a single observation = ± 26′. Period = 252 years.
1791.25...	—7.43	—6.34	—1.09	1.1881	
1821......	—8.67	—8.33	—0.34	0.1156	
1837......	—8.85	—9.05	+0.20	0.0400	
1838......	—8.78	—9.07	+0.29	0.0841	
1839......	—9.00	—9.10	+0.10	0.0100	
1841......	—9.20	—9.18	—0.02	0.0004	
1874......	—9.10	—9.17	+0.07	0.0049	
1880......	—9.30	—8.97	—0.33	0.1089	
				2.4929	

Empirical equation for determining the variation for any year: $v = -6.597 - 0.558 \sin \frac{10}{7}(t-1850) - 2.761 \cos \frac{10}{7}(t-1850)$.

Lat. 15° 55′ S. **ST. HELENA.** Long. 5° 44′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1610.5....	— 7.22	Davis	Hansteen's Magnetismus der Erde, Christiana, 1819.
1677.5....	— 0.67	Halley	
1691.5....	+ 1.00	.....do	
1724.5....	+ 7.50	Mathews	
1775.5....	+12.30	Cook	
1789.5....	+15.50	Hunter	
1796.5....	+15.80	Macdonald	
1806.5....	+17.30	Krusenstern	
1839.5....	+22.28	Du Petit Thouars	Magnetic and Meteorological Observations by Maj. Gen. Edw. Sabine.
1840.5....	+22.88	Ross	Phil. Trans. Royal Society, Part II, 1877.
1845.5....	+23.25		Do.
1846.5....	+23.19	Bérard	Magnetical and Meteorological Observations by Maj. Gen. Edw. Sabine.
1890.1....	+23.95	E. D. Preston, assistant, United States Coast and Geodetic Survey.	Bulletin No. 23, United States Coast and Geodetic Survey, May, 1891.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1610.5....	— 7.22	—7.51	+0.29	0.0841	Probable error of a single observation = ±41.8′. Period = 600 years.
1677.5....	— 0.67	—1.29	+0.62	0.3844	
1691.5....	+ 1.00	0.61	+0.39	0.1521	
1724.5....	+ 7.50	5.93	+1.57	2.4649	
1775.5....	+12.30	14.25	—1.95	3.8025	
1789.5....	+15.50	16.31	—0.81	0.6561	
1796.5....	+15.80	17.28	—1.48	2.1904	
1806.5....	+17.30	17.57	—0.27	0.0729	
1839.5....	+22.28	21.94	+0.34	0.1156	
1840.5....	+22.88	22.55	+0.33	0.1089	
1845.5....	+23.25	22.64	+0.61	0.3721	
1846.5....	+23.19	22.66	+0.53	0.2809	
1890.1....	+23.95	23.80	+0.15	0.0225	
				10.7074	

Empirical equation for determining the variation for any year: $v = 7.90 + 5.92 \sin 0.6\,(t - 1850) + 14.78 \cos 0.6\,(t - 1850)$.

Lat. 16° 53′ N. **ST. VINCENT, CAPE VERDE ISLANDS.** Long. 24° 59′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1615......	0.00	....	Arcano del Mare.
1700......	3.75	Edmund Halley..............	Tabula Nautica, etc.
1822.5....	15.05	Duperrey....................	Phil. Trans. Royal Society, vol. 5, 1875.
1874.9....	18.68	Nares and Thomson	Voyage of H. M. S. Challenger, vol. 2.
1882.5....	19.27	Lieut. Barnardières, Fr. N..	Annales Hydrographiques, 1884.
1884.8....	19.78	Lieut. J. D. Adams..........	Naval Prof. Papers, No. 19.
1889.9....	20.75	E. D. Preston, assistant, United States Coast and Geodetic Survey.	United States Coast and Geodetic Report, 1891, part 2.
1894.2....	20.75	Lieut. J. C. Cresap, U. S. S. Bennington.	Hydrographic Office Publication, No. 109.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1615......	0.00	0.33	−0.33	0.1089	Probable error of a single observation = ± 25′. Period = 600 years.
1700......	3.75	3.28	+0.47	0.2209	
1822.5....	15.05	15.39	−0.34	0.1156	
1873.6....	18.68	19.33	−0.65	0.4225	
1876.3....	19.27	19.71	−0.44	0.1936	
1884.8....	19.78	19.81	−0.03	0.0009	
1889.9....	20.75	20.02	+0.73	0.5329	
1894.2....	20.75	20.17	+0.58	0.3364	
				1.9317	

Empirical equation for determining the variation for any year: $v = 10.48 + 7.2 \sin 0.6\,(t-1850) + 7.25 \cos 0.6\,(t-1850)$.

Lat. 32° 43′ N. **SAN DIEGO, CAL.** Long. 117° 10′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1783.3....	—10 43	Spanish navigators..........	Appendix, No. 7, C. and G. Sur. Rep., 1888.
1792......	—11.00	Capt. G. Vancouver.........	Vancouver's Voyage of Discovery, 1790–95; also Hansteen's Magnetismus der Erde, 1819.
1839......	—12.34	Sir Edw. Belcher............	Phil. Trans. Royal Society, 1841.
1851.3....	—12.48	G. Davidson, assistant, Coast Survey.	Coast Survey Report for 1856.
1853.8....	—12.26	Lieut. W. P. Trowbridge, assistant, Coast Survey.	Do.
1866.5....	—13.15	W. Harkness, Professor, U. S. N.	Smithsonian Contributions to Knowledge, No. 239, Washington, 1873.
1872.9....	—13.32	G. Davidson, assistant, Coast Survey. S. R. Throckmorton.	Coast and Geodetic Survey Report for 1881, Appendix 9.
1881.3....	—13.46	Lieut. Commander H. E. Nichols, U. S. N.	Do.
1888.5....	—13.07	Lieut. C. F. Pond, U. S. N..	Notice to Mariners, United States Hydrographic Office, No. 41, 1888.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$	
	°	°			
1783.3....	—10.43	—10.63	+0.20	0.0400	Probable error of a single observation = +11. Period = 240 years.
1792......	—11.00	..10.79	—0.21	0.0441	
1839......	—12.34	—12.26	—0.08	0.0064	
1851.3....	—12.48	—12.64	+0.16	0.0256	
1853.8....	—12.26	—12.71	+0.45	0.2025	
1866.5....	—13.15	—13.00	—0.15	0.0225	
1872.9....	—13.32	—13.09	—0.23	0.0529	
1881.3....	—13.46	—13.17	—0.29	0.0841	
1888.5....	—13.07	—13.18	+0.11	0.0121	
				0.4902	

Empirical equation for determining the variation for any year: $v = 11.847 - 1.099 \sin \frac{3}{2} (t - 1850) - 0.758 \cos \frac{3}{2} (t - 1850)$.

Lat. 31° 15′ N.

SHANGHAI.

Long. 121° 29′ E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1858......	+1.83	Novara Expedition.........	Phil. Trans. Royal Society, 1875.
1875......	+1.98	Jesuit missionaries.........	"The Meteorological Elements of the Climate of Shanghai, Zi-Ka-Wei Observatory."
1876......	+2.02		
1877......	+2.02		
1878......	+2.00		
1879......	+2.02		
1880......	+2.03		
1881......	+2.05		
1882......	+2.09		
1883......	+2.08		
1884......	+2.13		

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.	
	°	°			
1858......	1.83	1.92	−0.09	0.0081	Probable error of a single observation= ± 1.62′.
1875......	1.98	2.00	−0.02	0.0004	
1876......	2.02	2.01	+0.01	0.0001	
1877......	2.02	2.02	0.00	0.0000	
1878......	2.00	2.02	−0.02	0.0004	
1879......	2.02	2.03	−0.01	0.0001	
1880......	2.03	2.04	−0.01	0.0001	
1881......	2.05	2.05	0.00	0,0000	
1882......	2.09	2.06	+0.03	0.0009	
1883......	2.08	2.07	+0.01	0.0001	
1884......	2.13	2.08	+0.05	0.0025	
				0.0127	

Empirical equation for determining the variation for any year: $v=1.9084-0.000012\,(t-1850)+0.000149\,(t-1850)^2$.

Lat. 1° 18′ N. **SINGAPORE.** Long. 103° 51′ E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1824......	—1. 83	Bougainville	Becquerel's Traité du Magnetisme.
1830......	—2. 00	La Place.....................	Do.
1843......	—1. 72	Beecher......................	Phil. Trans. Royal Society, Part I, 1875.
1846......	—1. 60	Elliott......................	Do.
1876. 5....	—2. 53	Dr. Van Ryckworsel........	Trans. Royal Academy of Sciences, Amsterdam, 1880.
1890. 5....	—2. 57	Lieut. Courmes, Fr. N......	Notice to Mariners, No. 38, 1890.

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.	
	°	°			
1824......	—1. 83	—1. 52	—0. 31	0. 0961	Probable error of a single observation=±17′. Period=400 years.
1830......	—2. 00	—1. 78	—0 22	0. 0484	
1843......	—1. 72	—2. 03	+0. 31	0. 0961	
1846......	—1. 60	—2. 10	+0. 50	0. 2500	
1876. 5....	—2. 53	—2. 47	—0. 06	0. 0036	
1890. 5....	—2. 57	—2. 42	—0. 15	0. 0225	
				0. 5167	

Empirical equation for determining the variation for any year: $v=0.24-1.18 \sin \frac{9}{10}(t-1850)-2.4307 \cos \frac{9}{10}(t-1850)$.

Lat. 7° 14′ S. **SURABAYA, JAVA.** Long. 112° 45′ E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1793......	+2. 52	....	Brewster's Treatise on Magnetism, Edinburg, 1837.
1824. 7....	+0. 17	Duperrey......................	Becquerel's Traité du Magnetisme.
1844......	—0. 97	H. M. S. Fly..................	Phil. Trans. Royal Society, Part II, 1877.
1847......	—0. 87	Elliot..........................	Do.
1860......	—1. 33	Denham	Do.
1874. 7....	—1. 73	Dr. Van Ryckworsel.......	Trans. Royal Academy of Sciences, Amsterdam, 1880.
1876. 2....	—1. 99		

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.	
	°	°			
1793......	+2. 52	+2. 46	+0. 06	0. 0036	Probable error of a single observation = ±6.′36. Period=400 years.
1824. 7....	+0. 17	+0. 26	—0. 09	0. 0081	
1844......	—0. 97	—0. 82	—0. 15	0. 0225	
1847......	—0. 87	—0. 95	+0. 08	0. 0064	
1860......	—1. 33	—1. 46	+0. 13	0. 0169	
1874. 7....	—1. 73	—1. 83	+0. 10	0. 0100	
1876. 2....	—1. 99	—1. 85	—0. 14	0. 0196	
				0. 0871	

Empirical equation for determining the variation for any year: $v=2.744-2.706 \sin \frac{9}{10}(t-1850)-3.832 \cos \frac{9}{10}(t-1850)$.

Lat. 33° 52′ S. **SYDNEY.** Long. 151° 12′ E.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1770......	— 8.00	Cook........................	Voyage of the Adventure and Beagle, 1826-36, London, 1839.
1787......	— 8.50	Hunter	Do.
1793.2....	— 8.77	....	Brewster's Treatise on Magnetism, Edinburg, 1834.
1803......	— 8.85	Flinders	Voyage of the Adventure and Beagle, 1826-36 London, 1839.
1813......	— 8.87	Brewster	Hydrographic Office, archive document.
1818.5....	— 8.78	—8.70, Capt. King, 1817.7... —8.93, Freycinet, 1819.......	Do. Voyage of the Adventure and Beagle, 1826-36, London, 1839.
1823......	— 8.83	—8.81, Brewster, 1822 .... —8.80, Rumker and Sir T. Brisbane, 1823. —8.93, Brewster, 1824	Hydrographic Office, archive document. Do. Do.
1841......	— 9.90	—9.85, Erebus, 1841 .... —9.95, Sir J. C. Ross, 1841...	Phil. Trans. Royal Society, Part II, 1877. Hydrographic Office, archive document.
1844......	— 9.42	H. M. S. Fly..................	Phil. Trans. Royal Society, Part II, 1877.
1848.5....	—10.12	—10.08, Rattlesnake, 1848... —10.15, Rattlesnake, 1849...	Do.
1851.5....	— 9.76	—9.72, Admiral King, 1851.. —9.80, Admiral King, 1852..	A letter from director of Government observatory at Sydney, dated 1890. Do.
1858......	—10.00	Capt. Denham................	Do.
1864...... 1866.5....	— 9.82 — 9.72	Smalley.......................	Do.
1872......	— 9.57	—9.62, Russell, 1870.......... —9.58, Russell, 1871.......... —9.57, Russell, 1872.......... —9.53, Russell, 1873.......... —9.55, Russell, 1874..........	Do.
1875......	— 9.52	—9.47, H. M. S. Challenger, May, 1874. —9.55, Russell, June, 1875...	Do.
1880......	— 9.58	—9.53, Russell, 1878.......... —9.58, Russell, 1879.......... —9.60, Russell, 1880.......... —9.60, Russell, 1881.......... —9.60, Russell, 1882..........	Do.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1770......	— 8.00	—7.82	—0.18	0.0324	Probable error of a single observation = ± 10.44′. Period = 324 years.
1787......	— 8.50	—8.35	—0.15	0.0225	
1793.2....	— 8.77	—8.53	—0.24	0.0576	
1803......	— 8.85	—8.82	—0.03	0.0009	
1813......	— 8.87	—9.08	+0.21	0.0441	
1818.5....	— 8.78	—9.22	+0.44	0.1936	
1823.6....	— 8.83	—9.32	+0.49	0.2401	
1841......	— 9.90	—9.62	—0.28	0.0784	
1844......	— 9.42	—9.63	+0.21	0.0441	
1848.5....	—10.12	—9.68	—0.44	0.1936	
1851.5....	— 9.76	—9.70	—0.06	0.0036	
1858......	—10.00	—9.73	—0.27	0.0729	
1864......	— 9.82	—9.72	—0.10	0.0100	
1866.5....	— 9.72	—9.72	0.00	0.0000	
1872......	— 9.57	—9.70	+0.13	0.0169	
1875......	— 9.52	—9.67	+0.15	0.0225	
1880......	— 9.58	—9.60	+0.02	0.0004	
				0.8556	

Empirical equation for determining the variation for any year: $v = -8.119 - 0.3239 \sin 1.112\,(t-1850) - 1.5765 \cos 1.112\,(t-1850)$.

Lat. 17° 31′ S. **TAHITI, SOCIETY ISLANDS.** Long. 149° 34′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1768	—5.25	—5.75, Wallis, 1767 —4.75, Cook, 1769	Hansteen's Magnetismus der Erde, Christiana, 1879. Voyage of the Adventure and Beagle, London, 1839.
1774.6	—5.68	—5.67, Wales, 1773 —5.82, Bayley, 1774 —5.57, Cook, 1777	Do.
1794	—6.20	Vancouver	Do.
1824.3	—7.02	—6.67, Duperrey, 1823 —6.83, Kotzebue, 1824 —7.55, Beechey, 1826	Voyage autour de Monde, Paris, 1829. Phil. Trans. Royal Society, 1877. Do.
1833	—7.53	—7.50, Irland, 1831 —7.57, Fitz Roy, 1835	Do.
1838.5	—6.80	—7.17, Bruce, 1837 —6.50, Belcher, 1840	Do.
1859	—7.18	—6.90, Friesach, 1859 —7.45, Novara Expedition, 1859.	Do.
1871	—7.77		Hydrographic Office, archive document.
1875	—7.78	—8.04, Nares & Thomson, R. N., 1875. —7.58, Nares & Thomson, R. N., 1875. —7.85, Nares & Thomson, R. N., 1875.	Report of Challenger Expedition.
1878	—7.55		Letter from French hydrographer.

Year.	Observed.	Computed.	O-C.	$\overline{\text{O-C}}^2$.	
	°	°			
1768	—5.25	—5.07	—0.18	0.0324	
1774.6	—5.68	—5.28	—0.40	0.1600	
1794	—6.20	—5.93	—0.27	0.0729	
1824.3	—7.02	—6.87	—0.15	0.0225	
1833	—7.53	—7.08	—0.45	0.2025	Probable error of a single observation = ± 14′.
1838.5	—6.80	—7.22	+0.42	0.1764	Period = 360 years.
1859	—7.18	—7.52	+0.34	0.1156	
1871	—7.77	—7.58	—0.19	0.0361	
1875	—7.78	—7.58	—0.20	0.0400	
1878	—7.55	—7.58	+0.03	0.0000	
				0.8593	

Empirical equation for determining the variation for any year: $v = -5.64 - 0.8288 \sin(t - 1850) - 1.7697 \cos(t - 1850)$.

Lat. 33° 02′ S. **VALPARAISO.** Long. 71° 39′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1709	— 9.50	Feuillée	Phil. Trans. Royal Society, 1877.
1744	—12.50		Voyage of the Adventure and Beagle, London, 1839.
1793	—14.82		Do.
1802	—14.92		Becquerel's Traité du Magnetisme.
1821	—14.72	B. Hall	Do.
1823	—15.68	Morrell	Phil Trans. Royal Society, 1877.
1825	—15.87	Beechey	Do.
1831	—15.00	King	Do.
1835	—15.30	Laplace	Do.
1837	—15.58	Beechey	Do.
1838	—15.60	La Venus	Do.
1859	—15.67	Novara Expedition	Do.
1866	—15.85	Harkness	Smithsonian Contributions to Knowledge, No. 239, 1873.
1882.6	—15.43	Lieuts. Barnardières and Barnaud, Fr. N.	French Magnetic Survey.
1883.2	—15.25	.....do	Annales Hydrographiques, 1884.
1884	—15.68	Lieut. J. W. Carlin, U. S. N.	Hydrographic Office Publication, No. 109.

Year.	Observed.	Computed.	O–C.	$\overline{O-C}^2$.	
	°	°			
1709	— 9.50	—10.24	+0.74	0.5476	
1744	—12.50	—11.98	—0.52	0.2704	
1793	—14.82	—14.38	—0.44	0.1936	
1802	—14.92	—14.76	—0.16	0.0256	
1821	—14.72	—15.39	+0.67	0.4489	
1823	—15.68	—15.44	—0.24	0.0576	
1825	—15.87	—15.49	—0.38	0.1444	
1831	—15.00	—15.61	+0.61	0.3721	Probable error of a single observation = ± 18′.
1835	—15.30	—15.67	+0.37	0.1369	Period = 360 years.
1837	—15.58	—15.69	+0.11	0.0121	
1838	—15.60	—15.69	+0.09	0.0081	
1859	—15.67	—15.72	+0.05	0.0025	
1866	—15.85	—15.63	—0.22	0.0484	
1882.6	—15.43	—15.24	—0.19	0.0361	
1883.2	—15.25	—15.23	—0.02	0.0004	
1883.9	—15.68	—15.21	—0.47	0.2209	
				2.5256	

Empirical equation for determining the variation for any year: $v. = -12.639 + 0.047 \sin (t-1850) - 3.124 \cos (t-1850)$.

Lat 19° 12′ N. **VERA CRUZ, MEXICO.** Long. 96° 08′ W.

Year.	Variation of compass.	Authority.	
		Observer.	Where recorded.
	°		
1726......	—2.15	Harris......................	Phil. Trans. Royal Society (Abridged), 1824-34.
1769......	—6.57	....	Encyclopædia Britannica, 7th ed.
1776......	—7.50	Don Ulloa	Do.
1819......	—9.27	Wise.........................	Do.
1839......	—8.37	Behard	Phil. Trans. Royal Society, 1875.
1856......	—8.28	Müller & Sontag............	Do.
1861......	—8.33	....	British Admiralty Chart 523; corrected, 1861.
1880.2....	—7.33	Lieut. Ackley, U. S. N.......	Appendix 12, Coast and Geodetic Survey Report, 1882.
1888.1....	—7.20	Lieut. Aubrey, Fr. N........	Annales Hydrographiques, 2d vol., 1888.
1888.9....	—7.18	Lieuts. Laird and Holcombe, U. S. N.	Notice to Mariners, No. 31, 1889.

Year.	Observed.	Computed.	O-C.	$\overline{O-C}^2$.	
	°	°			
1726......	—2.15	—3.10	+0.95	0.9025	Probable error of a single observation = ± 29′. Period = 360 years.
1769......	—6.57	—5.97	—0.60	0.3600	
1776......	—7.50	—6.42	—1.08	1.1664	
1819......	—9.27	—8.39	—0.88	0.7744	
1839......	—8.37	—8.67	+0.30	0.0900	
1856......	—8.28	—8.54	+0.26	0.0676	
1861......	—8.33	—8.44	+0.11	0.0121	
1880.2....	—7.33	—7.80	+0.47	0.2209	
1888.1....	—7.20	—7.43	+0.23	0.0529	
1888.9....	—7.18	—7.39	+0.21	0.0441	
				3.6909	

Empirical equation for determining the variation for any year: $v. = -4.768 + 0.608 \sin (t - 1850) - 3.86 \cos (t - 1850)$.

Serial number.	Station.	Latitude.			Longitude.			Equation for variation for any year A. D.
		°	'		°	'		
1	Aden	12	47	N.	44	59	E.	$v=9.20-4.24 \sin \frac{9}{11} (t-1850) - 4.09 \cos \frac{9}{11} (t-1850)$.
2	Arica, Peru	18	28	S.	70	20.5	W.	$v=-9.40+0.223 \sin 1.5 (t-1850) -14.61 \cos 1.5 (t-1850)$.
3	Ascension Island	7	55.5	S.	14	24	W.	$v=10.55+9.47 \sin 0.6 (t-1850) + 9.56 \cos 0.6 (t-1850)$.
4	Auckland, New Zealand	36	50	S.	174	49	E.	$v=-13.077+0.2295 \sin 1.1 (t-1850) -1.052 \cos 1.1 (t-1850)$.
5	Bahia Brazil	13	00	S.	38	32	W.	$v=-0.78+7.86 \sin \frac{18}{19} (t-1850) + 7.40 \cos \frac{18}{19} (t-1850)$.
6	Batavia Java	6	08	S.	106	48	E.	$v=1.494-1.194 \sin 0.9 (t-1850) - 2.928 \cos 0.9 (t-1850)$.
7	Bombay	18	05.6	N.	72	54	E.	$v=2.665-1.625 \sin 0.8 (t-1850) - 3.08 \cos 0.8 (t-1850)$.
8	Bridgetown	13	05	N.	59	37	W.	$v=-1.54+2.62 \sin 1.2 (t-1850) +0.812 \cos 1.2 (t-1850)$.
9	Buenos Ayres	34	36	S.	58	22	W.	$v=-12.032+3.448 \sin (t-1850) + 0.611 \cos (t-1850)$.
10	Callao, Peru	12	04	S.	77	08	W.	$v=-8\ 45-0.105 \sin 1.2 (t-1850) -2.16 \cos 1.2 (t-1850)$.
11	Cartagena	10	25	N.	75	32	W.	$v=-5.81+1.92 \sin 1.2 (t-1850) +0.794 \cos 1.2 (t-1850)$.
12	Cape of Good Hope	33	56	S.	18	29	E.	$v=14.63+3.178 \sin 0.61 (t-1850) +14.659 \cos 0.61 (t-1850)$.
13	Charlottetown, Prince Edward Island.	46	14	N.	63	08	W.	$v=15.15+1.714 \sin \frac{18}{19} (t-1850) + 7.766 \cos \frac{18}{19} (t-1850)$.
14	City of Mexico	19	26	N.	99	05	W.	$v=-5.52+0.027 \sin (t-1850) - 3.09 \cos (t-1850)$.
15	Concepcion	36	42	S.	73	07	W.	$v=-13.626-0.829 \sin (t-1850) -3.424 \cos (t-1850)$.
16	Coquimbo	29	57	S.	71	22	W.	$v=-11.55-0.281 \sin (t-1850) - 2.82 \cos (t-1850)$.
17	Curaçao	12	07	N.	68	57	W.	$v=-4.94+2.60 \sin (t-1850) + 1.107 \cos (t-1850)$.
18	Fayal. Azores	38	32	N.	28	33	W.	$v=11.82+0.23 \sin \frac{36}{53} (t-1850) + 14.75 \cos \frac{36}{53} (t-1850)$.
19	Fort de France	14	36	N.	61	04	W.	$v=-2.726+2.926 \sin \frac{12}{11} (t-1850) +1.528 \cos \frac{12}{11} (t-1850)$.
20	Galapagos Islands	1	00	S.	90	00	W.	$v=-7.491+0.069 \sin 1.5 (t-1850) -1.91 \cos 1.5 (t-1850)$.
21	Halifax. Nova Scotia	44	39.6	N.	63	35.3	W.	$v=16.74+3.32 \sin \frac{36}{35} (t-1850) + 2.74 \cos \frac{36}{35} (t-1850)$.
22	Habana	23	09	N.	82	22	W.	$v=-3.42+2.36 \sin (t-1850) - 2.07 \cos (t-1850)$.
23	Hongkong	22	16	N.	114	10	E.	$v=0.99+0.389 \sin 0.8 (t-1850) - 2.047 \cos 0.8 (t-1850)$.
24	La Guayra	10	36	N.	66	56.5	W.	$v=-3.382+1.623 \sin (t-1850) - 0.0659 \cos (t-1850)$.
25	Lagoon Head, Mexico	28	15	N.	114	06	W.	$v=-9.845-1.289 \sin \frac{10}{7} (t-1850) -1.519 \cos \frac{10}{7} (t-1850)$.
26	Magdalena Bay	24	38	N.	112	07	W.	$v=-7.484-1.469 \sin \frac{10}{7} (t-1850) -2.739 \cos \frac{10}{7} (t-1850)$.
27	Manila, Luzon Island	14	36	N.	120	58	E.	$v=-0.223-0.399 \sin (t-1850) - 0.418 \cos (t-1850)$.
28	Montevideo	34	54	S.	56	12	W.	$v=-10.28+3.9 \sin (t-1850) - 0.119 \cos (t-1850)$.
29	Nagasaki	32	43	N.	129	51	E.	$v = 2.74 + 0.0237 (t - 1850) + 0.0000774 (t-1850)^2$.
30	Nosy Vé	23	39	S.	43	36	E.	$v=15.31-6.883 \sin 0.6 (t-1850) + 4.629 \cos 0.6 (t-1850.)$
31	Panama	8	57	N.	79	32	W.	$v=-6.54+1.367 \sin 1.8 (t-1850) +0.105 \cos 1.8 (t-1850)$.
32	Payta, Peru	5	05	S.	81	05.5	W.	$v=-7.417+0.556 \sin 1.2 (t-1850) -1.67 \cos 1.2 (t-1850)$.

Serial number.	Epoch of nearest elongation.		Probable error of a single computed value.	Variation			Annual change.		
	Eastern.	Western.		1895.	1900.	1905	1895.	1900.	1905
			′	°	°	°	′	′	′
1	1906	1686	±43.0	+ 3.38	+ 3.33	+ 3.31	−1.00	−0.56	−0.11
2	1844	1964	±06.0	− 9.75	− 9.57	− 9.40	+2.20	+2.30	+2.30
3	1624.55	1924.55	±22.6	+23.37	+23.56	+23.71	+2.58	+2.15	+1.73
4	1740.4	1904	±10.0	−13.90	−13.89	−13.91	+0.10	+0.10	−0.01
5	1709.3	1899.3	±28.0	+10.00	+10.01	+ 9.96	+0.78	−0.10	−1.00
6	1874	1674	±15.0	− 1.51	− 1.42	− 1.32	+0.95	+1.16	+1.28
7	1884.8	2109.8	±12.0	− 0.79	− 0.74	− 0.67	+0.42	+0.63	+0.82
8	1760.6	1910.6	±15.0	+ 1.06	+ 1.14	+ 1.18	+0.92	+0.63	+0.33
9	1750	1930	±38.0	− 9.16	− 9.00	− 8.85	+2.10	+1.84	+1.55
10	1852.33	2002.33	±12.2	− 9.80	− 9.62	− 9.43	+2.13	+2.18	+2.23
11	1756.4	1906.4	±15.8	− 3.79	− 3.75	− 3.73	+0.61	+0.34	+0.07
12	2165	1870	±22.5	+29.10	+28.88	+28.60	−2.52	−3.00	−3.49
13	2053.15	1863.15	±20.0	+22.02	+21.67	+21.27	−3.97	−4.53	−5.05
14	1850.5	2030.5	±14.0	− 7.68	− 7.48	− 7.27	+2.31	+2.50	+2.68
15	1863.6	1683.6	±23.2	−16.64	−16.46	−16.27	+1.94	+2.20	+2.45
16	1855.7	1675.7	±21.0	−13.74	−13.58	−13.40	+1.88	+2.06	+2.25
17	1736.9	1916.9	±13.7	− 2.29	− 2.20	− 2.15	+1.11	+0.87	+0.62
18	1585	1850	±46.0	+24.63	+24.19	+23.68	−5.21	−5.72	−6.25
19	1757	1907	±19.0	+ 0.49	+ 0.54	+ 0.57	+0.76	+0.45	+0.14
20	1848.6	1968.6	±25.0	− 8.16	− 7.92	− 7.67	+2.82	+2.93	+3.00
21	2074	1899	±26.0	+21.03	+21.05	+21.02	+0.22	−0.07	−0.47
22	1801.25	1981.25	±17.0	− 3.21	− 2.94	− 2.68	+3.29	+3.25	+3.19
23	1839	2064	±15.0	− 0.44	− 0.33	− 0.21	+1.27	+1.36	+1.43
24	1762.3	1942.3	±21.0	− 2.28	− 2.18	− 2.09	+1.26	+1.14	+1.03
25	1878	2004	±09.0	−11.66	−11.54	−11.40	+1.214	+1.54	+1.83
26	1870	1996	±35.0	− 9.99	− 9.74	− 9.46	+2.74	+3.20	+3.59
27	1893.7	2073.7	±08.3	− 0.80	− 0.80	− 0.79	+0.01	+0.07	+0.12
28	1761.75	1941.75	±12.3	− 7.61	− 7.38	− 7.16	+2.97	+2.72	+2.56
29	....	....	±05.1	+ 3.88	+ 4.02	+ 4.16	+1.70	+1.73	+1.76
30	2057	1757	±30.0	+16.31	+15.88	+15.45	−5.18	−5.20	−5.19
31	1797	1897	±13.0	− 5.21	− 5.17	− 5.21	+1.91	−1.89	−5.65
32	1834.75	1984.75	±14.2	− 7.85	− 7.74	− 7.59	+2.10	+2.17	+2.21

Serial number.	Station.	Latitude.			Longitude.			Equation for variation for any year A. D.
		°	′		°	′		
33	Peking	39	54	N.	116	28	E.	$v = 2.179 + 0.0131\,(t - 1850) - 0.000117\,(t - 1850)^2$.
34	Pernambuco	8	03	S.	34	52	W.	$v = 8.994 + 9.451 \sin 0.9\,(t - 1850) - 0.539 \cos 0.9\,(t - 1850)$.
35	Petropaulowski	53	01	N.	158	43	E.	$v = -2.682 + 3.349 \sin \frac{1}{7}^{\circ}\,(t - 1850 + 0.0156 \cos \frac{1}{7}^{\circ}\,(t - 1850)$.
36	Puna and Guayaquil	2 2	45 13	S. S.	79	52	W.	$v = -8.459 + 0.0201\,(t - 1850) + 0.0001\,(t - 1850)^2$.
37	Punta Arenas	53	10	S.	70	54	W.	$v = -18.68 + 2.71 \sin\,(t - 1850) - 4.35 \cos\,(t - 1850)$.
38	Rio de Janeiro	22	54	S.	43	10	W.	$v = 1.814 + 8.655 \sin\,(t - 1850) - 1.825 \cos\,(t - 1850)$.
39	St. Johns, Newfoundland	47	34	N.	52	41	W.	$v = 15.634 + 4.8 \sin\,(t - 1850) + 14.76 \cos\,(t - 1850)$.
40	San Blas, Mexico	21	32	N.	105	19	W.	$v = -6.597 - 0.558 \sin \frac{1}{7}^{\circ}\,(t - 1850) - 2.761 \cos \frac{1}{7}^{\circ}\,(t - 1850)$.
41	St. Helena	15	55	S.	5	44	N.	$v = 7.90 + 5.92 \sin 0.6\,(t - 1850) + 14.78 \cos 0.6\,(t - 1850)$.
42	St. Vincent	16	53	N.	24	59	W.	$v = 10.48 + 7.2 \sin 0.6\,(t - 1850) + 7.25 \cos 0.6\,(t - 1850)$.
43	San Diego, Cal	32	43	N.	117	10.3	W.	$v = -11.847 - 1.099 \sin 1.5\,(t - 1850) - 0.758 \cos 1.5\,(t - 1850)$.
44	Shanghai	31	15	N.	121	29	E.	$v = 1.9084 - 0.000012\,(t - 1850) + 0.000149\,(t - 1850)^2$.
45	Singapore	1	18	N.	103	51	E.	$v = 0.24 - 1.18 \sin 0.9\,(t - 1850) - 2\ 4307 \cos 0.9\,(t - 1850)$.
46	Surabaya, Java	7	14	S.	112	45	E.	$v = 2.744 - 2.706 \sin 0.9\,(t - 1850) - 3.832 \cos 0.9\,(t - 1850)$.
47	Sydney	33	52	S.	151	12	E.	$v = -8.119 - 0.3239 \sin \frac{1}{9}^{\circ}\,(t - 1850) - 1.5765 \cos \frac{1}{9}^{\circ}\,(t - 1850)$.
48	Tahiti, Society Islands	17	31	S.	149	34	W.	$v = -5.64 - 0.8288 \sin\,(t - 1850) - 1.7607 \cos\,(t - 1850)$.
49	Valparaiso	33	02	S.	71	39	W.	$v = -12.639 + 0.047 \sin\,(t - 1850) - 3.124 \cos\,(t - 1850)$.
50	Vera Cruz	19	12	N.	96	08	W.	$v = -4.768 + 0.608 \sin\,(t - 1850) - 3.86 \cos\,(t - 1850)$.

Serial number.	Epoch of nearest elongation.		Probable error of a single computed value.	Variation			Annual change.		
	Eastern.	Western.		1895.	1900.	1905.	1895.	1900.	1905.
			'	°	°	°	'	'	'
33	1794	…………	±06.0	+ 3 00	+ 3.12	+ 3.25	+1 41	+1.49	+1.56
34	1753.6	1953.6	±17.4	+14.71	+15.29	+15.82	+7.12	+6.67	+6.17
35	1736.8	1912.8	±21.3	+ 0 35	+ 0 50	+ 0.61	+2 17	+1.57	+0.97
36	1750	…………	±10 0	— 7.35	— 7.20	— 7.05	+1.74	+1.80	+1.86
37	1818	1998	±16.6	—19.83	—19.41	—18.95	+5.24	+5.32	+5.37
38	1772	1952	±25.0	+ 6.64	+ 7.27	+ 7.85	+7.78	+7.31	+6.79
39	1688	1868	±17.4	+29.17	+28.51	+27.74	—7.40	—8.63	—9.81
40	1859	1733	±26.0	— 8.30	— 8.01	— 7.70	+3.37	+3.66	+3.88
41	1586	1886	±41.8	+23.76	+23.66	+23.53	—0.90	—1.42	—1.94
42	1625	1925	±25.0	+20.20	+20.36	+20.48	+1.96	+1.64	+1.31
43	1887	1767	±11.0	—13.16	—13.11	—13.04	+0.60	+0.71	+0.96
44	…………	…………	± 1.6	+ 2.20	+ 2.27	+ 2.35	+0.80	+0.89	+0.98
45	1878	1678	±17.0	— 2.38	— 2.32	— 2.24	+0.64	+0.83	+1.02
46	1889	1689	±06.4	— 1.92	— 1.88	— 1.80	+0.40	+0.75	+1.10
47	1860.3	1698.3	±10.4	— 9.37	— 9.28	— 9.17	+1.05	+1.18	+1.29
48	1875	1695	±14.0	— 7.48	— 7.41	— 7.35	+0.70	+0.86	+1.02
49	1849	1669	±18.0	—14.81	—14.61	—14.39	+2.35	+2.54	+2.72
50	1841	1661	±29.0	— 7.07	— 6.78	— 6.48	+3.31	+3.52	+4.16

Astr 6278.95.3
Contributions to terrestrial magnet
Cabot Science 003363405
3 2044 091 924 423